POWER

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Right of Appeal

A manufacturer had but recently completed a modernization job that, on test, showed a yearly saving rate of over three times its total cost to the purchaser.

A second contract was later entered into between the same two companies for a similar modernization scheme at another plant, but inadvertently the seller did not notice a clause in the buyer's specification providing that failure to meet guaranteed efficiency above a certain minimum would be balanced by a proportionate reduction in the contract price. That is to say, a realization of only half the saving promised would mean that the seller would be entitled to only half the contract price.

Now it so happened that, due to failure or inability of the buyer to provide the engineering conditions upon which the guaranty was based, the saving was actually only about half that expected. And, there was no clause in the specification to cover this.

So the purchaser's agent insisted that the letter of the contract should be observed and was adamant even when shown that despite the unfavorable conditions the new job would earn more than twice its cost for the buyer in the first year's operation.

The seller could not believe the policy of the purchasing company would support its agent's view and so addressed a letter to the company setting forth the facts and asking for payment in full. To the everlasting glory of the big boss, he verified the facts and promptly reversed the agent's decision. The seller was paid in full.

There is generally someone in authority in every organization to whom a seller may successfully appeal for fair play under proper circumstances.

EDITORIALS

Court Backs License Law

For several years New York and several other states, have required the licensing of professional engineers. Although sponsored and supported by some of the engineering societies, the New York statute has not been regarded sympathetically by many engineers. This may be because the application of engineering is so broad that it is felt the law, in its present form, provides little protection to the public. Until recently enforcement has been lax.

A reader now inquires whether, as a graduate of an engineering university of accepted standing, but not registered within the state as a professional engineer, he is privileged to use the title M.E. on his letterheads. Apparently there is no prohibition against one signing his degree after his name or having it on his stationery providing he does not employ this as a means to practicing professional engineering. For his information and for the guidance of others who may entertain similar doubts, a recent decision in the New York courts is pertinent. An engineering graduate of a foreign university was convicted on Feb. 25, 1932, in the Court of Special Sessions and received a sentence of sixty days for presuming to practice professional engineering, without a license, by describing himself on his business cards as a civil engineer. The competency of the individual was not questioned. Sentenced was suspended, as the case was regarded as a test to determine the legality of the law.

With the backing of this decision it is apparent that enforcement of the statute will become more rigid from now on.

English—Economics—Engineering

Without economics the engineer is blind. Without English he is dumb. Handicapped by poor training in these two fields of practical knowledge, he cannot go far in his profession. It is therefore a matter of importance to the next generation of engineers that many of their teachers will this summer assemble to study what to teach in these fields—and how.

Back of this project stands the Society for the Promotion of Engineering Education, which for five years past has conducted highly successful summer schools dealing with the more technical branches. More than one thousand teachers have attended and have gained new inspiration from informal contacts with creative spirits in the fields of engineering and pedagogy.

The better evaluation of economics and English by those who direct the work of engineering students has already had favorable results, but the ground has hardly been broken. How many students, even today, are really convinced that a good working knowledge of English will help them tremendously in getting a foothold in the world of affairs, and that it may easily add a thousand dollars or more to their yearly incomes ten years hence? How many understand that a *working* knowledge of economics will transmute their technical knowledge from the tools of a skilled workman into those of an engineering executive—the man who knows what *should* be done, not merely what has been?

So, good luck to the S.P.E.E. in its latest venture! From it we expect that engineering teachers will increase their own knowledge of English and economics, and learn better how to direct youthful energies into these green pastures.

Rescuing Dollars From The Stores Department

Large power systems and industries maintain extensive spare parts departments. Frequently these have grown as the plants expanded, until they represent very large investments in thousands of different pieces of equipment and materials, without serious thought being given to an efficient stores organization. Unless some standard method is adopted for specifying, ordering and listing each piece of equipment, much duplication is likely to occur and the investment in stores will be unnecessarily high, as experience has shown in many instances.

Using several names to designate a single item is an outstanding cause of duplication of parts and of confusion in cataloging available material and identifying it when ordered. If all material is purchased on a standard specification form and requisitioned in a similar way, purchasing agents and store keepers can then catalog each part in stock so it can be easily identified and mistakes prevented. Such a system will also avoid ordering more parts that are already in stock and will promote efficient handling of materials between store rooms and places of use.

Many parts such as carbon brushes, bolts, pipe and fittings afford opportunity for reducing their number in stock by standardizing on certain dimensions, types and other features.

When engineers are considering ways and means of reducing operating costs they should not ignore the lowly stores department. A dollar rescued from spare parts is worth just as much as one saved from the coal pile by improved operation.

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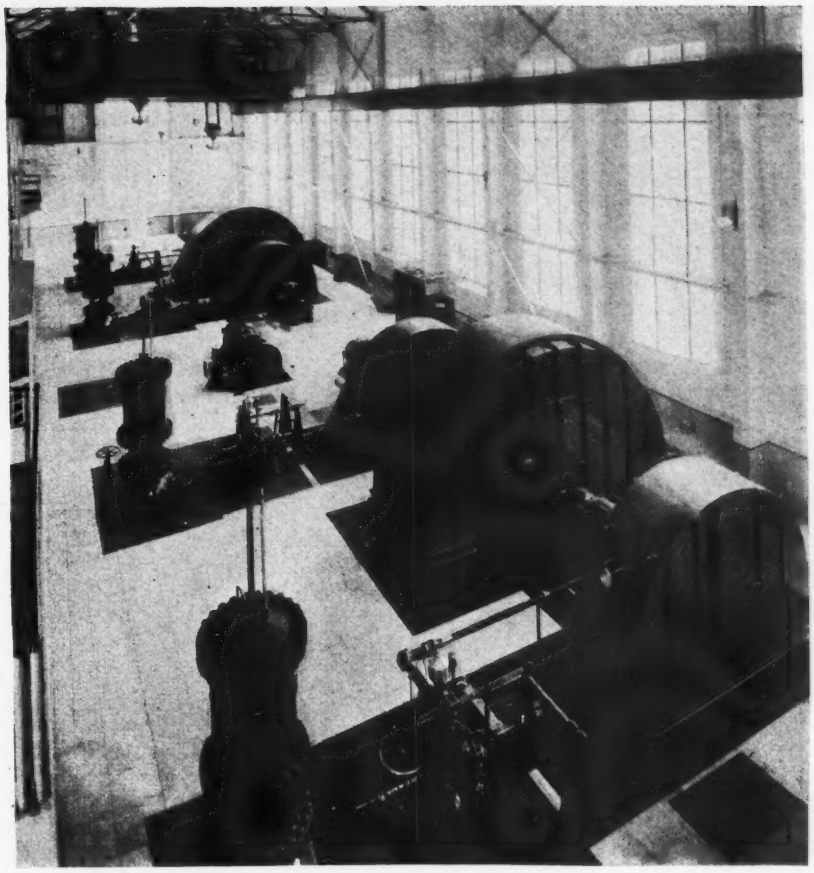
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Interior of Tiger-Creek plant, in which is installed two 36,000-hp. double overhung single - nozzle waterwheel units

By C. V. FOULDS
Vice President
The Pelton Water Wheel Company

Impulse Wheels Develop 87 Per Cent Efficiency

In the Tiger Creek plant of the Pacific Gas & Electric Company the installation and testing of two 36,000 hp., 1,190-ft. head impulse wheels was recently completed. These units involve a number of refinements with novel construction and operating features which contribute to simplicity and safety of operation

LOCATED on the Mokelumne River in California, the Tiger Creek plant of the Pacific Gas & Electric Company contains two double, overhung, single-nozzle, impulse-type waterwheel units, each rated at 36,000 hp., 225 r.p.m., 1,190-ft. net effective head. Each unit consists of a single shaft mounted in two ring-oiling, babbitted bearings, with waterwheel runners mounted at each end and a 30,000-kva., 11,000-volt alternating-current generator between the bearings. Water is supplied to the plant through a single penstock, with branches immediately behind the power house, to the four main nozzles. The penstock is 4,750 ft. long, so that precise governor action is of utmost importance in limiting pressure surges.

Each waterwheel runner weighs about 20 tons and consists of a rolled-steel disk to which are attached cast-steel buckets by means of body-bound bolts forced into place under hydraulic pressure. Each disk is attached directly to a low flange, Fig. 1, forged integrally with the shaft, by taper dowels, thus eliminating entirely the conventional hub and key and permitting minimum extension of the shaft beyond the wheel center. The construction permits ready removal and replacement of the runner, as no press fit is involved. This feature, in connection with the removable housing sections, permits the runner to be put on and taken off the main shaft while it is in the bearings.

Both installation and maintenance work are simplified and the required crane capacity is reduced, since the rotating element can be set in its bearings prior to installing the waterwheel runners. Should it be necessary to remove a runner for rebucketing or for repair, it may be done without disturbing the rest of the unit. The waterwheel runner can be removed and replaced conveniently for establishing definitely its friction and windage. The shaft flanges are small enough in diameter to pass through the bore of the generator rotor.

Nozzles of the straight-flow type are used in which the needles and discharging jets are in line with the axes of the inlet pipe connections. This avoids the turbulence incident to the elbows of the conventional needle nozzle.

Rigidly attached to each nozzle are the deflector mechanism for rapid load control and the complete governor actuator and operating cylinder, the whole forming a single self-contained unit. Fig. 2 shows two of the nozzles set up for shop tests and indicates the compactness of the design, as well as the way in which the nozzles lend themselves to a working test in the shop prior to installation.

Complete waterwheel housings, consisting of upper removable cover portions and lower base frames, are fabricated of structural-steel plate by electric welding. It has been regular practice to construct cover housings of steel plate, but so far as known this is the first time that structural-steel base frames have been used for wheels of large size. They have been found to possess advantages over the cast-iron and cast-steel previously used. Base frames are essentially large structures of comparatively light cross-section and when cast are subject to distortion as well as to breakage in handling, shipping and erection. Structural-steel bases, on the other hand, are made flat and true to shape, any distortion being corrected as it develops.

Fabricated construction is lighter than castings of corresponding strength and permit the use of welded joints to seal them to the pit liners, nozzle bodies and similar related parts. In event of damage from handling or from débris carried by water, they may easily be repaired and straightened. Fabricated construction is conducive to securing of the best possible bond with the concrete foundation. Fig. 4 shows the base frames and indicates the means provided for securing firm anchorage. Each lower base frame contains a removable floor section at the outboard side of the runner to permit its being traversed laterally sufficiently to clear the end of the shaft for removal.

The rotating element of each unit weighs 204 tons and is carried by two 24x72-in. rigid, ring-oiling water-cooled babbitted bearings. The bearing barrels are of comparatively thin cast steel, supported along their lengths by diaphragms cast in their bases, Fig. 3. While many successful ball-and-socket bearings of large size have been constructed, the rigid bearings have been found to possess advantages of lighter weight, freedom from distortion and low maintenance.

Three separate means of water cooling are provided for the bearings. First, by jackets formed on the bearing barrels proper, through which water is circulated. Second, through cooling tubes submerged in the oil in the pedestal base. Third, by the flow of spray through the hollow-bored main shaft from one wheel housing to the other. This flow is positively induced by a special centrifugal pumping action at the exciter end of each shaft. As a result of the effective cooling, the bearings operate at room temperature. Any one of the cooling means may be discontinued for maintenance without the bearings exceeding the safe limit of operating temperature. At the outboard end of each bearing a special housing is provided to contain and lubricate the spiral-ring gear that drives the governor head.

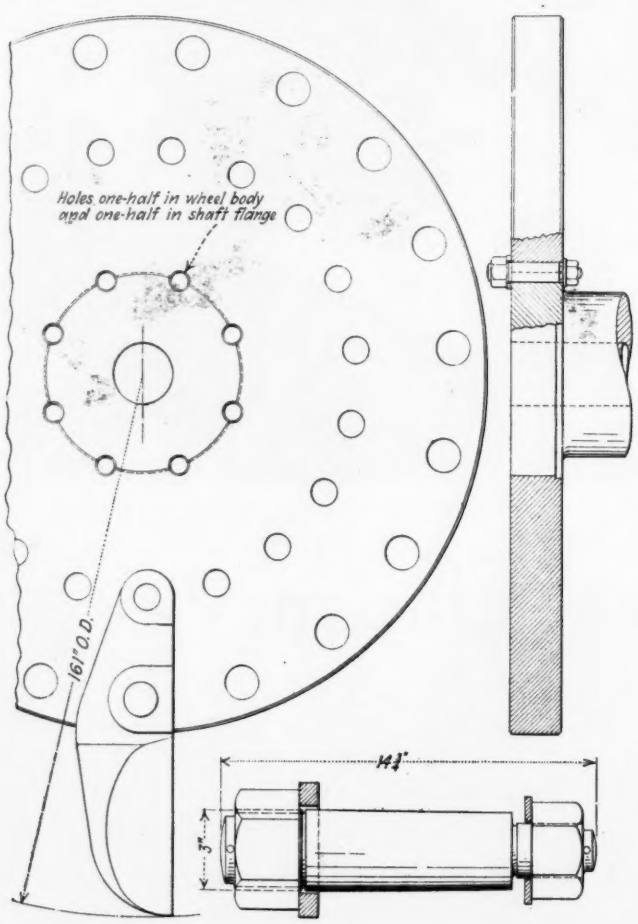


Fig. 1 — Each waterwheel runner consists of a rolled-steel disk to which are attached cast-steel buckets by means of bodybound bolts forced into place under hydraulic pressure. Each disk is attached by tapered dowels directly to a low flange forged integrally with the shaft

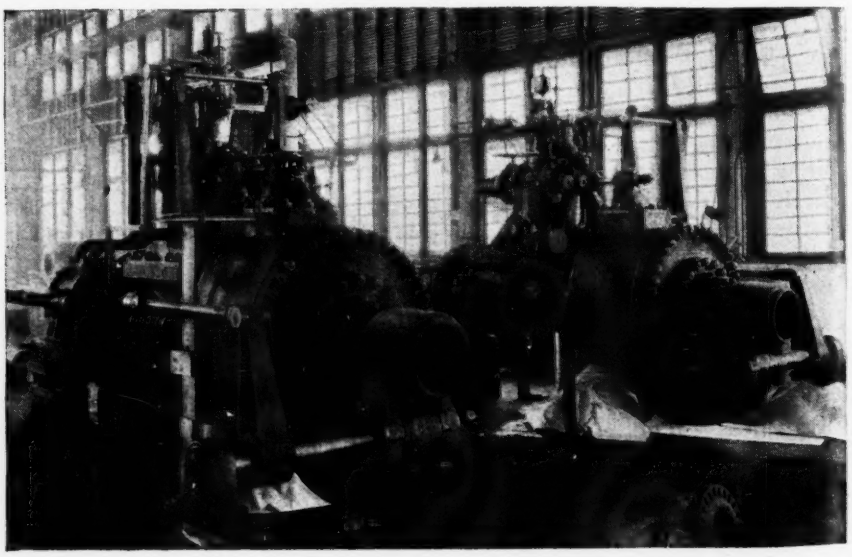


Fig. 2—Rigidly attached to each nozzle are the deflector mechanism for rapid load control, the complete governor and operating cylinder, the whole forming a single self-contained unit

The technique of fitting large bearings has developed to where it is possible to complete all required scraping operations during erection of the unit before it is started for the first time by its own power. Then the housings are sealed with grease against the entrance of foreign matter and not opened again. Initial operation at low speed for a period of 24 to 48 hr. suffices for running in the bearings, after which the unit is brought up to speed and load without further consideration being given them. This practice has been followed with all of the medium and large-size bearings that have been put in service during the last several years by the Pelton company and in no instance has it been necessary to open the bearings for any supplementary scraping or refitting.

Provisions are made in the design of the bearings for the possible later application of auxiliary lubrication by means of either flood oiling or by supplying high-pressure oil to the center of the barrel's lower half. As installed and operated, the eight oil rings have been found sufficient and not the slightest distress has been indicated in the bearings even with repeated starts and stops.

Each main unit is equipped with a self-contained exciter and pilot exciter. These are driven from an extension of the main shaft through a floating shaft jointed at the ends by the internal-external gears of Fasts couplings. The floating section of shaft is approximately 2 ft. in length, so that the angular movement at each joint is small, due to the lateral variation in the position of the main shaft with load. The extension is bolted in place and contains the pumping element to circulate the spray through the main shaft. It is readily removable for maintenance and repairs or for removing the wheel runner. In addition to the main exciters direct-connected to each of the units, there is provided an entirely separate waterwheel-driven motor-generator exciter unit. It is a conventional small waterwheel unit with independent speed governor controlling needle.

One wheel of each unit is equipped with a hydraulic brake consisting of a fixed nozzle through which a high-pressure stream may be directed against the backs of the buckets. The flow through the brake nozzle is controlled by a needle-pilot valve conveniently located with respect to the operator's position at the governor. The brake is capable of bringing the rotating element to a standstill from full speed in 6 min., compared to several hours required to drift to a stop without the brake.

Each nozzle is provided with an independent speed-responsive governor element, gear-driven from the main shaft. It is arranged to control the unit's speed and output through the combined action of a regulating needle to adjust the water flow and a sleeve-type jet deflector to divert any required portion of the flow from the wheel runner. The combination needle-deflector control was originated by the Pelton Water Wheel Company about 30 yr. ago and was later widely adopted in various forms by European manufacturers. Because of the complexity of the early designs it was not widely used in this country for units of large size, in view of the simplicity of the bypassing relief nozzle developed a little later. The present design is a new development eliminating many of the complications of earlier forms while retaining full advantage of the system.

Pressure oil is used as the operating medium, under control of a simple pilot-operated, four-way valve. This valve regulates the supply of oil to the two independent cylinders connected in parallel for operating the needle and jet deflector. The motions of the two controlling elements are so biased by springs as to cause them normally to take up positions with the deflector clear of the stream with the needle at the opening required to maintain the speed set by the governor.

Gradual changes in speed cause small flows of oil through the governor control valve. If the flows can be accommodated by movements of the needle-operating piston at something less than its maximum permitted rate of travel only the needle piston moves. Sudden changes of speed cause such a large flow of oil through the control valve that only a portion of it can be used by the needle piston traveling at its maximum permissible rate. The balance of the oil goes to the deflector cylinder to divert the water from the wheel. Thus if the needle has been standing for some time at the half-open position a gradual decrease of load will cause it to move slowly in

Fig. 4 (Right)—Welded, fabricated-steel base frames are used for the wheels and have been found to possess advantages over the cast-iron construction previously employed

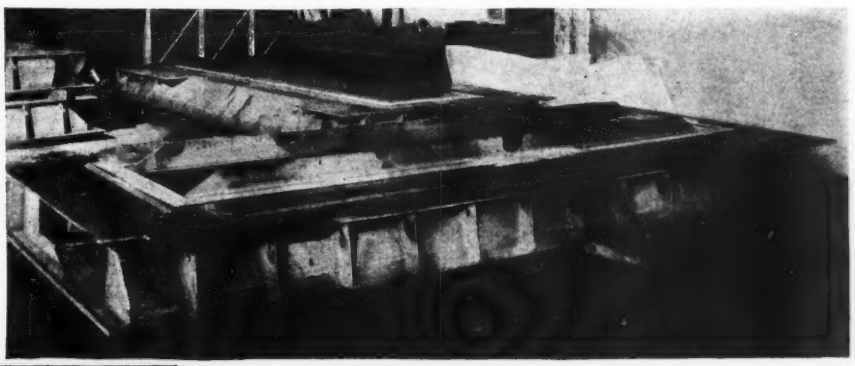
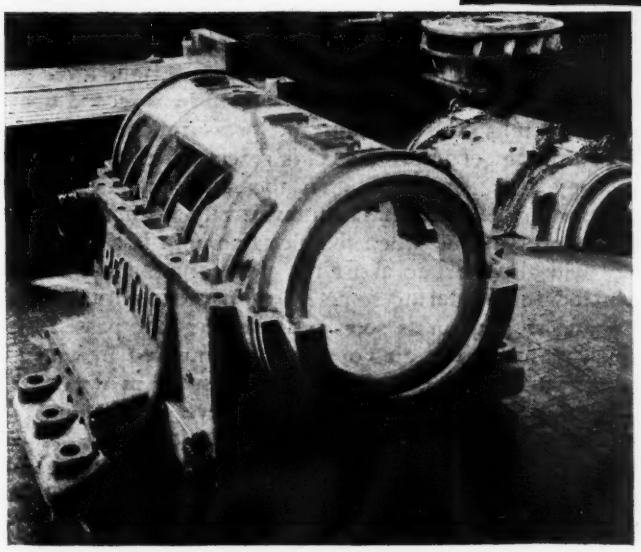


Fig. 3 (Below)—The rotating element of each unit weighs 204 tons and is supported in two 24x72-in. rigid, ring-oiling babbitted, water-cooled bearings supported by diaphragms cast in their base



the closing direction. On the other hand, a rapid decrease of load will cause the needle to close at its maximum rate and the deflector rapidly to divert the required amount of water from the wheel to maintain speed. If the load remains at the lesser value, without further assistance from the control valve, the oil will be interchanged between the ends of the deflector and needle cylinders. The deflector will slowly withdraw from the stream, while the needle will close to the required point to maintain speed. If the deflector is already clear an increase of load will cause the needle to slowly open at any required rate up to maximum.

Should the deflector be diverting a portion of the stream when the load came on, it would first rapidly

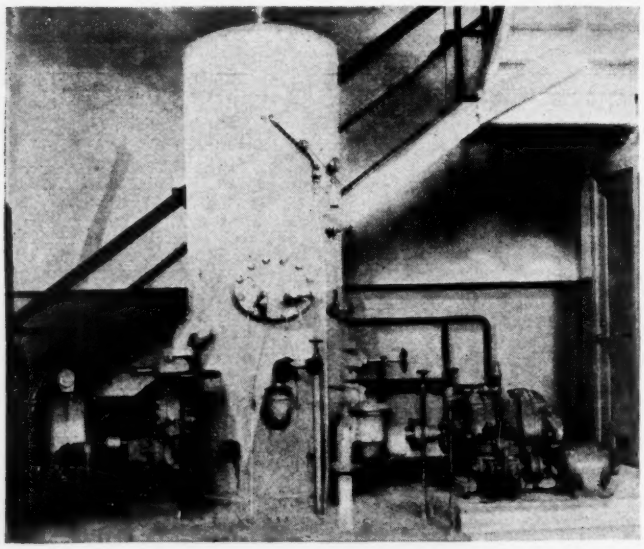


Fig. 5—Each unit is provided with an independent pressure system for supplying oil to its two governors

move clear of the stream and then be followed by the nozzle needle opening. The rates at which the needle may travel at different parts of its stroke are independently fixed by locked adjustments separate from the control valve and other controls normally manipulated by the operator, therefore, no mishandling can produce sudden movements of the needle that would cause pressure surges in the penstock.

The needle may also be controlled independently of the governor and deflector system, should it be desired to pass a constant quantity of water through the plant, regardless of load. This feature proved of real value during the initial stages of operation, when it was necessary to maintain a constant flow into the tailrace. By throwing of a single lever the system of control can be converted from water control by the governor to hand control of the water flow, with the governor operating the deflector only for speed regulation, exactly as with the simple deflector unit and without speed change or alteration of the governor setting. With the needle under such independent control the action of the governing system as a whole becomes the same as when a synchronous bypass is used. The flow is maintained irrespective of the load on the unit, the load, of course, being limited to the set quantity of water flowing.

The construction also permits, should water conditions warrant, applying an automatic water-level control to the needle. Thus, when desired, the plant would pass exactly the amount of water supplied to the forebay, with independent deflector control of the speed and load. For other conditions operation could be instantly changed back to automatic regulation of water flow, in accordance with load demands.

Each unit is provided with an independent oil-pressure system for supplying the two governors. Each pressure system consists of a single vertical cylindrical barrel with a diaphragm near the center dividing it into an upper pressure compartment and a lower sump tank. Mounting rings welded into the sump-tank portion furnish the supporting structure for the pumps. External piping consists only of the suction and discharge for each pump, to place the strainers and check valves accessibly. All auxiliary piping, such as unloader connections, drains, bleeders, etc., is within the sump tank. Aside from the small space occupied and the elimination of piping, the construction simplifies erection, as the unit is shop-fitted

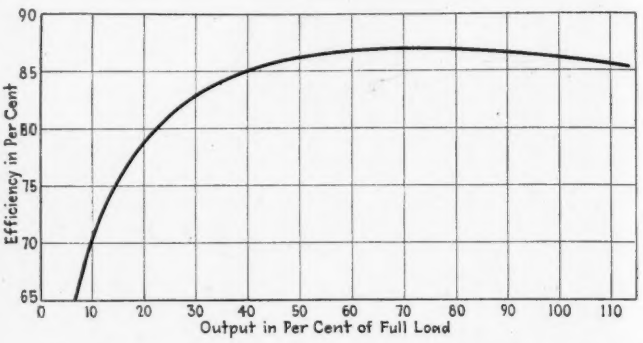


Fig. 6—Efficiency curve for No. 2 unit in Tiger Creek plant obtained by test at site

A maximum efficiency of 87 per cent was obtained. From 49 to 102 per cent rated load the efficiency was over 86 per cent, and between 40 and 113 per cent rated load the efficiency was over 85 per cent.

and assembled so that the tank and driving motor only have to be mounted in the field.

Two independent pumps are provided for each system. They are of the Quimby screw type, but of special construction to mount within the tank wall and to include in the pump bodies the unloaders and various auxiliary cored passages for the oil.

One pump, the normal source of pressure oil, is directly connected to an electric motor. It runs continuously and oil is delivered to the pressure compartment or returned to the sump by an unloader valve actuated by a float-operated pilot valve within the pressure compartment. The second pump is directly connected to a water motor and is the stand-by, or emergency source of supply. It is normally at rest, but should the oil in the pressure compartment fall below a certain level the water-motor-driven oil pump is started by a second float-operated pilot valve within the pressure compartment. When the upper limit of level is reached the water motor is stopped by the float. Thus the water motor will run intermittently to maintain automatically a sufficient supply of pressure oil when the electric pump is shut down, and will also start to assist the electric pump should the demand for oil during some emergency exceed its capacity, and stop again as soon as the emergency passed. A small motor-driven air compressor controlled by a pressure switch maintains the proper pressure in the upper tank and in combination with the level control of the pumps makes the entire system automatic.

All of the equipment was started and put into regular operation without incident. Not the slightest difficulties were experienced with the bearings or any of the major

parts and less than one-half hour was required for the adjustment of each nozzle and governor assembly. Following the usual period of low-speed operation for drying the generators, load rejection tests were made to assure the proper functioning of the speed- and pressure-control equipment, and immediately upon their completion regular operation was commenced.

Instantaneous rejection of full load on one wheel resulted in a speed rise of less than 11 per cent and a pressure rise of less than 2 per cent. Subsequent operating experiences have confirmed the values observed during the tests.

Due to the positive manner in which the rates of needle movement are limited, the machines are started and synchronized without producing more than 2 per cent swings in penstock pressure. The recording pressure charts show barely perceptible fluctuations as the various operations are performed and the impossibility of mishandling has had a great influence on the confidence and rapidity with which the operators handle the equipment.

Efficiency Tests Made

After a few weeks' operation, efficiency tests were made by the Allen salt-velocity method under the personal direction of E. A. Taylor, Professor Allen's associate, and the engineers of the Pacific Gas & Electric Company. The tests were made with the utmost care and attention to detail and included determination of generator characteristics and the windage and friction of the generator and waterwheel runners, so that no estimated quantities entered into the determination of the final results. Fig. 6 shows the efficiency output characteristics as established by the tests. The high maximum and well-sustained efficiency prove the units to be well adapted to the wide variations of load they must carry. A maximum of 87 per cent was obtained for the waterwheels. From 49 to 102 per cent rated load the efficiency was over 86 per cent, and between 40 and 113 per cent rated load the efficiency was over 85 per cent.

It is felt that the successful performance of the equipment is in large measure due to the hearty and helpful cooperation of the Pacific Gas & Electric Company engineers, and particularly to J. P. Jollyman and E. A. Crellin. It was through the close collaboration between them and the manufacturer that it was possible to build into the equipment the many novel features that have realized to the full their advantages as related to the conditions of the project as a whole.

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Crane Control Improved By Magnetic Switches

By O. ARIAGNO

Magnetic switches can be applied extensively in altering motor-control apparatus, to meet safety requirements and to obtain better operating conditions. One case where magnetic switches served to reverse the direction of rotation on a hoist motor, and to afford a safer limit stop, without the use of entirely new control equipment, is here mentioned. To meet safety requirements on a 30-ton crane, the limit stop device for the hoist motor had to be completely altered so that positive action could be obtained. The limit stop consisted of an iron rod 6 ft.

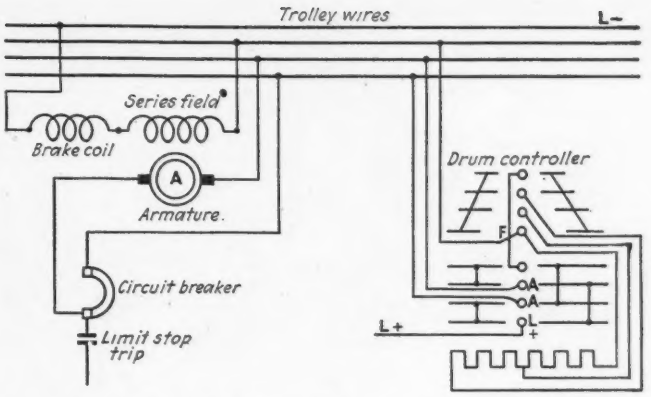


Diagram of original control and motor connections for the crane

long suspended underneath the carriage directly above the hoist block. A slight upward move would cause it to trip a circuit breaker connected in series with the hoist motor and stop the motor through a series-connected magnetic break. This limit stop was deficient in that it could not be depended upon for positive operation and, because of its location, was unsafe for the operator to reset.

Several methods to overcome this situation were developed on paper, but all required adding one or more trolley wires. Installation of additional trolley wires on this crane would have been difficult. A survey of the drum-type controller connections, Fig. 1, was made with the object of connecting the motor reversing elements of the controller directly to the hoist motor, and making it possible to use the two armature trolley wires for the limit switch.

This splitting up of the controller elements proved possible by using four motor-current capacity, magnetic switches. The controller was then connected as in Fig. 2, resulting in a semi-automatic remote control, with the magnetic switches mounted on the carriage, and operated from the cab with the drum controller. The limit stop device was changed to open the circuit to the magnetic switch coils 1 and 2, thus opening the armature circuit when hoisting, leaving switch 3 and 4 to operate for lowering.

When this method was tested it proved successful under all operating conditions. Its safety of operation is evident, and the total cost of the changeover, compared to that of substituting new control equipment, justifies the use of magnetic switches in improving other old motor controls.

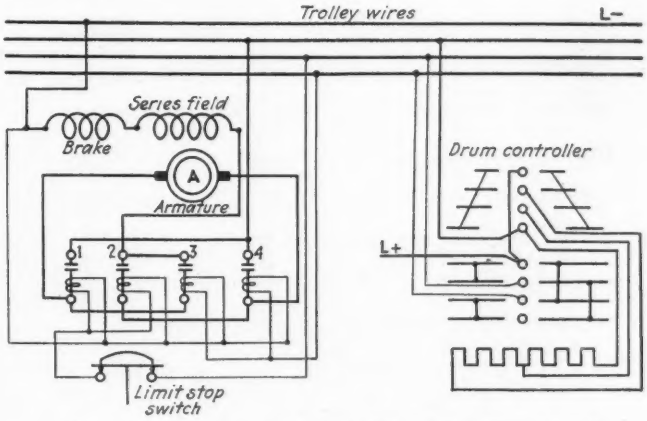
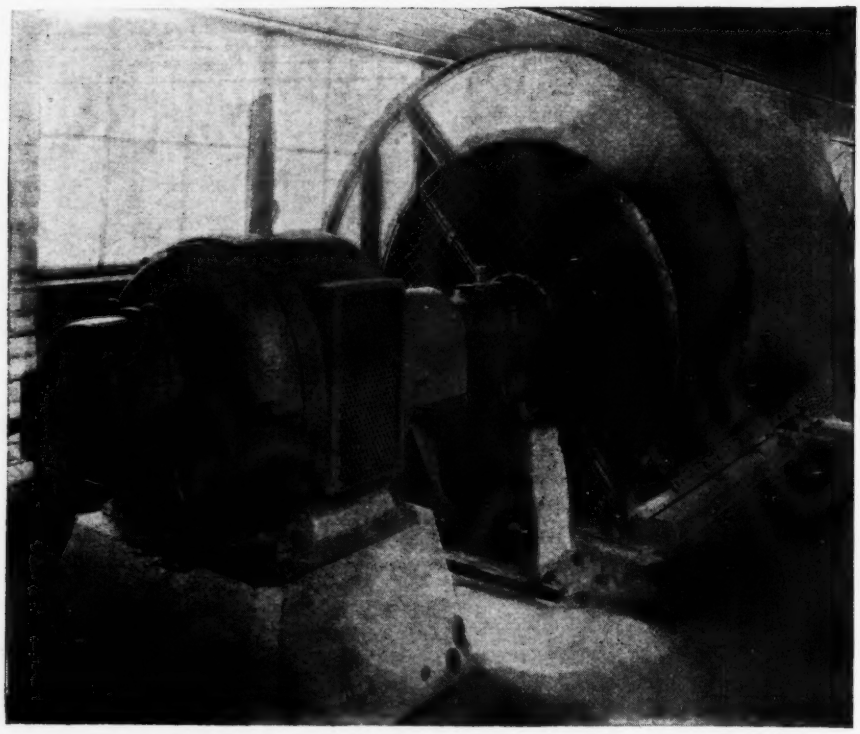


Diagram of crane-control connections after the magnetic reversing switches were added



Constant Versus Variable Speed For Auxiliary Drives

By E. H. THROCKMORTON
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United Light & Power Engineering & Construction Corporation
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Notable savings in power usage are possible through intelligent choice of drives for plant auxiliaries. Such choice, however, requires information only obtainable from careful analysis which evaluates the various engineering factors on a dollar basis. This article makes an economic comparison between variable- and constant-speed motor drive for a forced-draft fan. The method shown applies equally to other problems in this field

FOR THE past year or two, the plant engineer has been hard pressed to find ways and means to cut down the auxiliary power loss in his plant. The ordinary plant presents many problems of "drive," two of which are the drive for centrifugal pumps and fans. The application of variable-speed drive for centrifugal pumps and forced-draft fans is desirable where a variable volume of water or air is to be moved. This statement is especially true where the pump or fan discharges through a long line which has a high friction loss.

It is not generally appreciated that a saving up to 70 per cent of the power required for constant speed operation of a forced-draft stoker fan can be made by varying the speed of the fan to meet the demand of stoker for pressure and volume. This statement is also true for a centrifgual pump; however, the percentage of saving is ordinarily less for this application due to the fact that the plant condition will not permit of as wide a range of pressure and volume as is the case with the forced-draft fan. In order to estimate the power saving possible it will be necessary to take a specific problem and follow through the solution:

Find the most economic drive for a forced-draft stoker

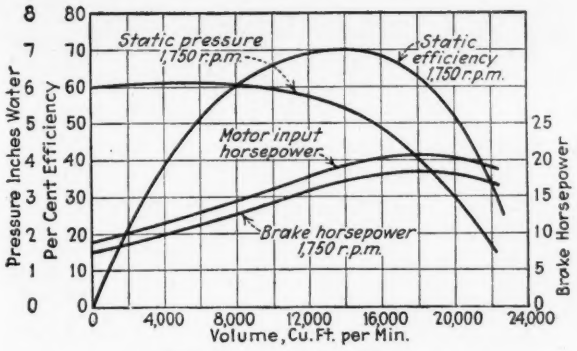

Fig. 1—Fan performance

fan which has constant speed characteristic curves as shown in Fig. I, when operated to supply air at a variable pressure and volume as shown by curve in Fig. II.

The curves in Fig. I show static efficiency, pressure, and brake horsepower plotted against volume in cubic feet. These curves are obtained from the fan manufacturer. The curve shown in Fig. II gives the volume and pressure required by the stoker over its range of operation. This curve is made up from data supplied by the stoker manufacturer combined with estimated friction loss in the duct system.

Fig. 3 shows curves for horsepower input, efficiency, and R.P.M. at variable speed for conditions given in Fig. 2, and also the constant-speed fan performance curves and resistance-pressure curves as given in Figs. 1 and 2.

The first step in the solution of the problem is to calculate the fan speed required to meet the volume and

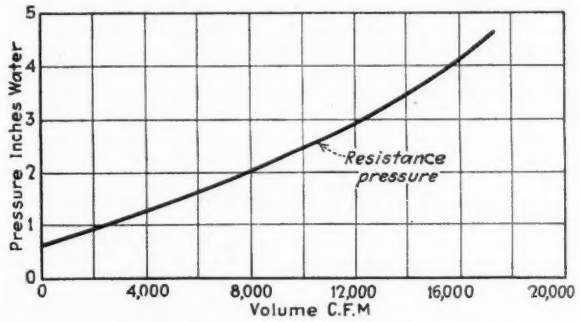

Fig. 2—System resistance and volume curves

pressure conditions as shown by the curve in Fig. 2. The performance of fans in general follows these laws:

1. Volume varies directly as the fan speed.
2. Pressure varies as the square of the fan speed.

Select on the curve showing resistance pressure, a point at say 10,000 cu.ft. per minute and 2.4 in. water pressure. Through this point draw a parabola and find the intersection with the static pressure curve for the fan in question. Any pressure-volume point on the parabola will have the same efficiency as the point at which the parabola crosses the static pressure curve.

To construct the parabola, use a slide rule. Set the runner on the square scale (A scale) to 2.4 in., and set 10,000 cu.ft. per min. on slide (C scale) to hair line on the runner. Then for $3\frac{1}{2}$ in. pressure on square scale (A scale), read on the slide (C scale) 12,100 cu.ft. per minute. Repeat for other points on the parabola. The parabola crosses the static pressure curve at 5.2 in. and 14,700 cu.ft. per minute. The fan speed to give 10,000 cu.ft. per minute at 2.4 in. will be directly proportional to 14,700 cu.ft. per minute and 1750 r.p.m. or

$$\frac{10{,}000}{14{,}700} = \frac{\text{r.p.m.}}{1750} = 1{,}190 \text{ r.p.m.}$$

Fan speed for other points on the resistance-pressure curve may be determined by constructing similar parabolas through the points selected. As before, the speeds required to give the volumes and static pressures indicated by the points chosen on the resistance curve are proportional to the volume points at which the parabolas cross the static pressure curve. Construction of a sufficient number of parabolas to give correct curve shape and calculation of corresponding speed points allows the plotting of the variable speed curve Fig. 3, showing revolutions per minute required for the resistance-pressure conditions. The construction of two such parabolas, one at 6,000 cu.ft. per minute and 1.65 in. press, and one

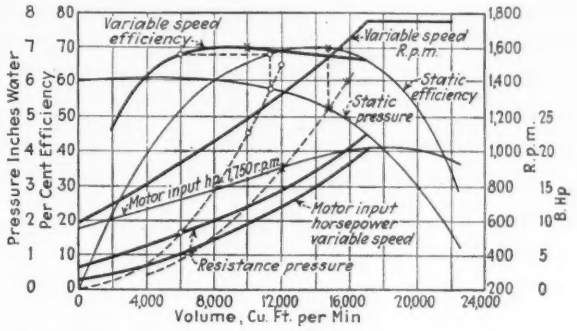

Fig. 3—Horsepower input, efficiency and speed curves for conditions of Fig. 2

at 10,000 cu.ft. per minute and 2.4 in. press, is shown by brokes lines on Fig. 3.

Fan efficiency at 2.4 in. and 10,000 cu.ft. per minute will be the same as that for the point at which parabola crosses the static pressure curve, or 69.4 per cent. The efficiency for other points will likewise be the same as that for the point at which each parabola crosses the static pressure curve. This is shown on Fig. 3 by the two projected points. Thus the variable-speed efficiency curve may be plotted showing efficiency for the resistance-pressure conditions.

The power required by fan at 2.4 in. and 10,000 cu.ft. per minute is 5.45 b.hp. and is obtained from the following formula:

Pressure, in inches of water × *cu.ft. per minute* 0 × .0001573 ÷ *efficiency* = *brake horsepower.*

The torque for 5.45 hp. is thus equal to 24 ft.-lb. The full load torque of motor is 60 ft.-lb. since it develops

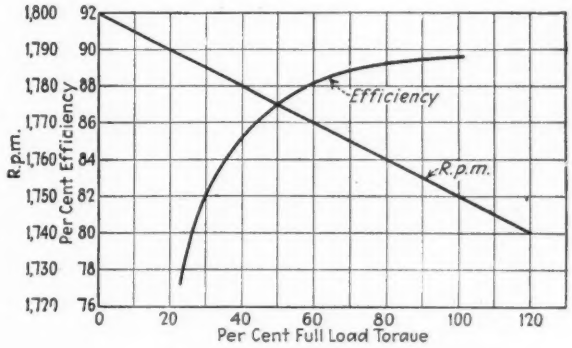

Fig. 4—Motor performance

20 b.hp. at full load. Thus when running at 1190 r.p.m. and pulling 5.45 hp., the motor develops $\frac{24}{60}$ or 40 per cent of full load torque.

The efficiency of a motor with external resistance in the secondary circuit is difficult to accurately estimate; however, it is closely approximated by the following formula:

$E = E_1 \times \frac{R}{R_1}$ where

E = Over-all efficiency of motor and external resistance.

E_1 = Efficiency of motor with no external resistance in secondary (obtain from Fig. 4.)

R = Speed of motor with external resistance in secondary circuit.

R_1 = Speed of motor with no external resistance in secondary when developing the same per cent of full load torque as motor with resistance in secondary. (Obtain from curve Fig. 4.)

From curves on Fig. 4 for 40 per cent torque, read 85 per cent efficiency and 1,780 r.p.m. for a motor operating with no external resistance in the secondary circuit. Multiply this efficiency by the ratio of speed at which motor was operated with resistance in the secondary circuit to a speed of 1,780 r.p.m.

Efficiency of motor and control is:

$$E = \frac{85 \times 1{,}190}{1{,}780} = 56.9 \text{ per cent}$$

Then the horsepower input to the motor is equal to $\frac{5.45}{0.569}$ or 9.6 hp.

The brake horsepower required for the fan if operated at 1,750 r.p.m.. and dampered to give 10,000 cu.ft. per minute at 5.9 in. of draft with a static efficiency of 65.5 per cent is 14.22 brake horsepower.

The motor torque under these conditions is 71 per cent of full load torque and its efficiency is 88.8 per cent. The horsepower input to the motor is equal to $\frac{14.22}{0.888}$ or 16 horsepower.

Power input saved by variable speed control is 16—9.6 or 6.4 hp. and the per cent power saving is $\frac{6.4 \times 100}{16}$ or 40 per cent.

A comparison of the motor input and brake horsepower at constant speed (1,750 r.p.m.) with motor input and

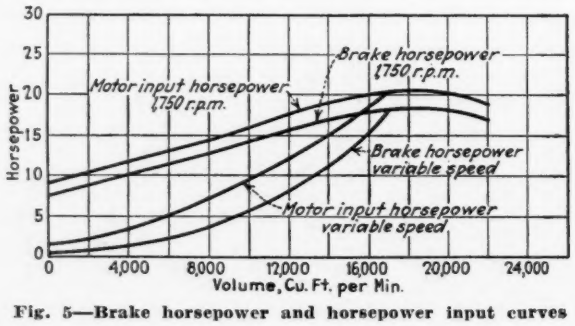

Fig. 5—Brake horsepower and horsepower input curves

brake horsepower at variable speed, (to meet the requirements of Fig. 2,) is shown in Fig. 5. A reduction in power input will be noted throughout the entire required range. It will be seen that at 4,000 cu.ft. per minute the horsepower input for variable speed is 3.5 and for constant speed 11.5 or a difference of 8 hp. which is equal to 69.5 per cent saving.

We have now estimated the amount of power which can be saved, and the next thing to be considered is the economics of the variable speed motor installation.

On the basis of operating the fan 5,500 hours per year at an average load of 8,000 cu.ft. per min. with electrical energy costing 1 cent per kwh., the cost to operate the fan would be as follows:

With constant speed drive 14.5 x 0.746x 5500 x $0.01 =	$594.94
For variable speed drive 7.3 x 0.746 x 5.500 x $0.01 =	299.52
Saving due to variable speed drive	$295.42

The cost of motor and control is as follows:

20-hp. squirrel-cage motor complete with hand compensator	$227.00
20-hp. wound rotor motor complete with 11 point drum controller	457.00
Increased cost of variable speed motor and control	$230.00

The fixed charges on $230.00 at 15 per cent capitalization is equal to $34.50 per year. It is apparent that the saving in power due to the variable-speed drive would not only carry the fixed charges but retire the additional investment for variable speed motor and control within one year's time.

The power saving which must be made per hour by variable-speed operation of the 20 hp. motor to carry additional investment for variable speed control is 0.84 hp. or approximately 1 hp. This will be possible in most all applications. From an inspection of curves shown in Fig. 5, it is apparent that the variable-speed motor and control will be a profitable investment over the entire range of operation.

The performance for a pump drive can be estimated by using the same methods as indicated in this article for the forced-draft fan. However, the saving which will be made on a variable-speed pump drive will not be as great as for the fan drive due to limitations in volume and pressure range.

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Reclaiming Lubricating Oil In a Refrigerating Plant

THE diesel power plant of the Gardeners' & Shippers' Ice Company of New Orleans, La., has a complete lubricating-oil-recovery system.

The reclaiming process is as follows: approximately 35 gal. of dirty oil is put into the treating tank and the heat turned on. To this is added 3 gal. of hot water into which has been thoroughly dissolved two standard packages of ordinary washing powder (tri-sodium phosphate may be used) and the mixture is well stirred to be sure that the washing powder solution is thoroughly distributed through the oil. The mixture is brought up to and maintained at a temperature of 200 to 210 deg. F. for one hour, being stirred now and then. The heat is then turned off and the batch allowed to settle for 48 hr. At the end of this time the heat is again turned on to warm up the oil before it is run through a centrifuge. A considerable quantity of muck is drained out of the bottom of the treating tank after all of the oil has been run through a centrifuge.

The reclaimed oil is as good as new oil and when used in the engine there is no evidence of increased bearing temperatures.—*De Laval Review.*

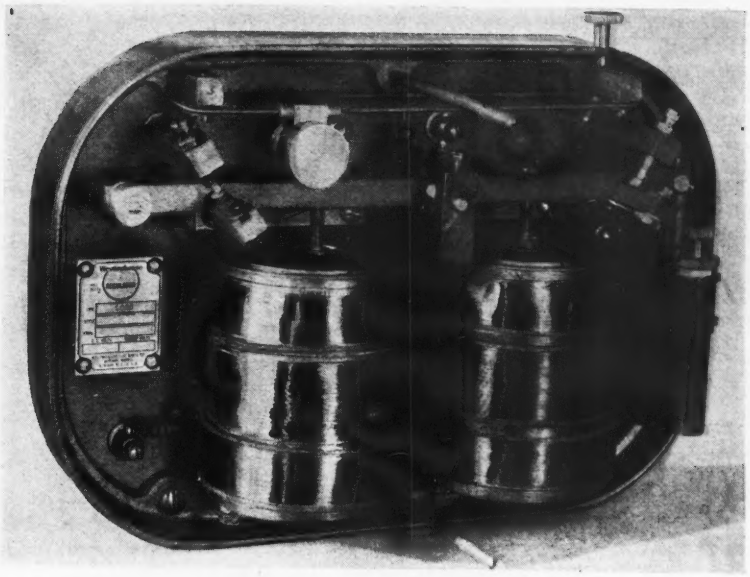

Fig. 1—An automatic polyphase kilowatt regulator

By R. A. GEISELMAN
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Automatic Load Regulation Reduces Power Costs

When an industrial power plant operates in parallel with a purchased-power supply the problem of maintaining the most economical division of load between the two power sources may be an important one. Means of obtaining the correct division of load automatically are described

SOME industries need process steam that is supplied as a byproduct from generating part of the power needed for driving manufacturing machinery. The remainder of the load is supplied from a central station, and in order to secure the most economical balance it is desirable to take load from the central station up to the limit of the contract. In the past, the purchased power taken was usually from 66 to 75 per cent of the allowable amount, the remainder being sacrificed in order to avoid a penalty for exceeding the maximum demand specified in the rate contract. A watt regulator will permit working closer to the allowable limit without exceeding the contract.

Fig. 2 shows an unregulated load curve. The peaks and valleys tend to produce an average, but in order to stay within the demand limit the peaks must be within this limit. This means that the valleys represent a loss that cannot be made up without the possibility of paying a penalty in the rate. This loss might appear quite small, but it can easily be of such proportions as to in a short time equal the cost of an automatic regulator. Fig. 3 shows the curve for an automatically regulated load. The improvement over Fig. 2 is self-evident.

A load regulator is shown in Fig. 1, and the connections for this equipment are given in Fig. 4. A polyphase element is represented for which the vector relationships of two potentials and currents are represented in Fig. 5. In this figure the voltages *e–1* and *e-2* make up voltage *E 2-1*, which leads the current *I-1*. This voltage and current is applied to the right-hand coil, Fig. 4. The voltages *e-2* and *e-3* give the resultant voltage *E 3–2*, which leads the current *I–3*. This voltage is reversed, giving *E 2–3*, which lags the current *I–3* and is applied to the left-hand coil. These voltages and currents give the true watt relationship with changes of power-factor. When the power factor lags the current *I–1* swings farther out of phase with voltage *E 2–1*, whereas the current *I–3* swings farther into phase with voltage *E–2–3*.

These potentials and currents are applied to their

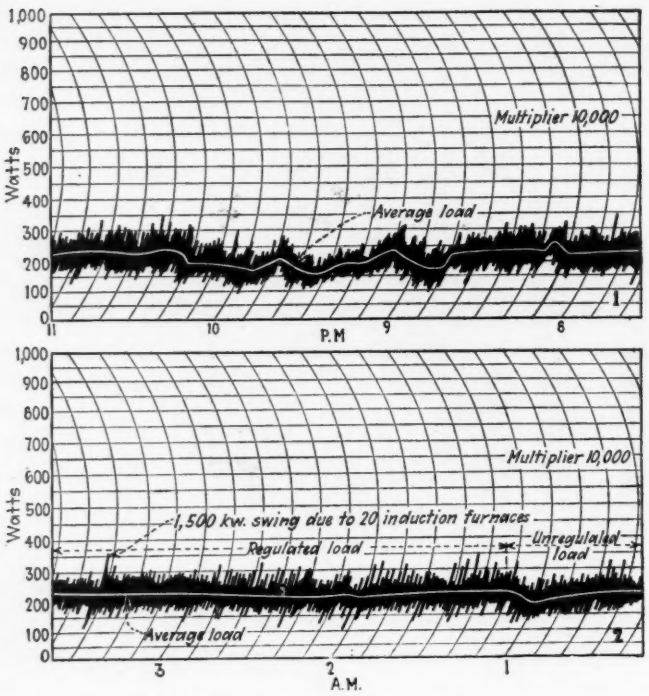

Fig. 2—Unregulated instantaneous load curve

Fig. 3—Regulated instantaneous load curve

respective coils in such a manner as to produce a torque in a counter-clockwise direction when regulating incoming power. This torque is opposed by a weight on top of the lever system. By changing the position of the weight the torque required to balance the lever can be changed from a maximum in one direction to zero, and to a maximum in the opposite direction, thus permitting the load to be set for any value between maximum incoming to maximum outgoing power by turning a knurled thumb nut.

Assume that the incoming power produces sufficient torque on the watt regulator to balance the floating lever midway between the stationary contacts. An increase in incoming power then causes contact R, Fig. 4, to close by rotating the lever in a counter-clockwise direction. Relay R then picks up, energizing the speed-changer motor, so as to start opening the throttle of the prime mover, thus causing the generator to carry more load. Since there is only a given amount of plant load to be supplied, the incoming power is reduced. When the line load is restored to normal the corrective action stops.

In like manner, a decrease in incoming power permits the weight to rotate the lever clockwise, closing contact L and relay L, so that the speed-changer motor reduces the power of the prime mover to decrease the load on the generator, and the load on the power line coming into the plant increases.

Anti-hunting means are provided by auxiliary potential windings placed over the current windings. Auxiliary-voltage windings are used, since at zero power flow there would be no current available for anti-hunting purposes. When the load has changed more than 15 per cent the speed-changer motor is run continuously. When the load error is less than 15 per cent the speed changer motor is run by an amount proportional to the error. This is accomplished by the vibrating state set up by the anti-hunting features.

Under manual operation it is customery to operate two machines of the same capacity with the load equally divided between them. When automatic control is used it is desirable to divide the load between the machines so as to secure the best operating conditions. With this type of control it must be recognized that the two or more generators will respond differently to the impulses applied to these governor motors of the prime movers. This is due to the difference in governor design, adjustments, motor speed, frictional load, coasting and starting qualities. Some means must be provided for maintaining the proper division of load between the generators and at the same time take a constant load from the outside power source, by varying the load on the two generators. To accomplish this, two regulators similar to that in Fig. 1 are used and connected as in Fig. 6.

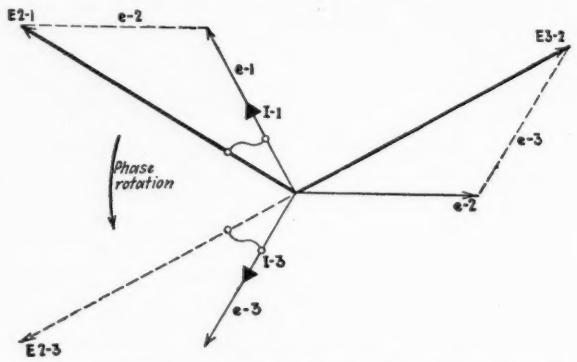

Fig. 5—Vector relation of voltages and currents used on polyphase kilowatt regulators, at unity power factor

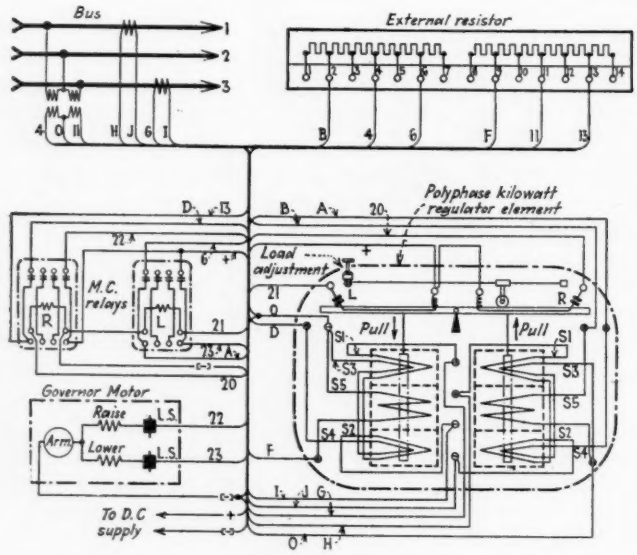

Fig. 4—Wiring diagram of a polyphase kilowatt regulator

The watt regulator A (Fig. 6) is used for measuring the line load and through relay R_1 sends the corrective action simultaneously to both governor motors for increasing the load on the generators, while an impulse through relay L_1 simultaneously causes both governor motors to reduce the load. This means that the line-load regulator A detects any error in that load and directly causes each governor motor to come into action. If one of the generators lags behind the other the watt-balance regulator B detects the load difference, since it measures the load in the generator leads. If the load unbalances sufficiently, the watt-balance regulator B closes one of its contacts, thereby causing an inter-

mediate relay to pick up and interrupt regulator A to cause the following operation:

Assuming that the regulating equipment were in service and both machines were carrying 103 per cent load, as illustrated in Fig. 7, and that the load suddenly dropped so that No. 2 and No. 3 machines would be required to supply only 80 per cent of their rating. Regulator A would immediately close relay L_1 to energize the governor motors, so that the motive power to the generators 2 and 3 would be decreased. Due to the

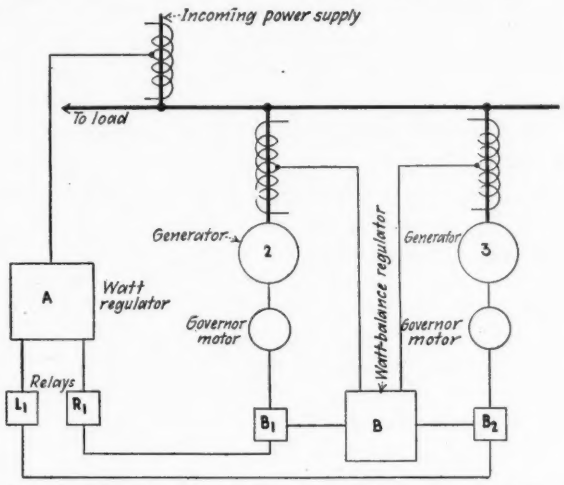

Fig. 6—Diagram showing how to maintain constant line load and let two generators take the fluctuations

difference to their response curves, Fig. 7, No. 2 generator will drop load faster than No. 3. For example, if the machines were allowed to perform normally, when the load on No. 2 generator had decreased to 80 per cent of normal, No. 3 generator would be loaded to about 88 per cent of full-load rating. This condition would exist about 27 sec. after the load began to decrease, as indi-

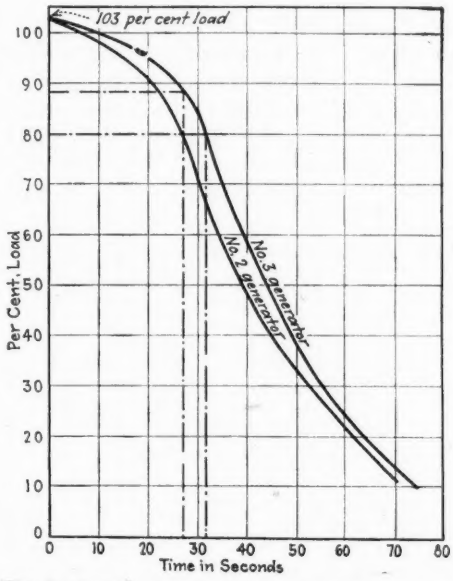

Fig. 7—Load response curves of two generators

cated by the dotted lines. Looking at this another way, it will take about 27 sec. for the load on generator No. 2 to decrease from 103 per cent to 80 per cent of normal. For generator No. 3 to do this will require about 32 seconds.

By applying a watt-balancing regulator between the two machines this difference in load will be detected. If the watt-balancing regulator B, Fig. 6, is set to act with an unbalance of 2 per cent, when this difference in load occurs the load-balancing element will close a contact and cause intermediate relay B_1 to stop regulator A for reducing the load on No. 2 generator. Regulator A, however, still can reduce the load on No. 3 machine, so that this generator approaches a balance with No. 2 generator. As soon as the loads are equalized regulator B opens its contact, thus permitting regulator A again to have control of both machines until sufficient unbalance is reached to cause the watt-balance regulator to come into action again. This operation is repeated as often as is necessary until the final load has been reached.

If the load increases and generator No. 3 picks up load faster than No. 2 the load-balancing regulator will again close its contacts and cause intermediate relay B_1 to interrupt the load-raising circuit of generator No. 3. This generator's rate of picking up load is decreased, thus permitting No. 2 to catch up with it.

Summarizing these operations, regulator A has control of both generators, whereas regulator B can take control of either generator away from regulator A so as to cut out the control on the high machine while picking up load and the low machine when dropping load. The result of this is to divide the load properly between the two machines at the same time taking a predetermined load from the outside power source. The permissible unbalance between generators can be adjusted by means of the contact gaps.

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Corrosion Costs Billion Yearly

LOSS traceable to the corrosion of metals is now more than $1,000,000,000 a year in the United States, according to Dr. Gustav Egloff of the Universal Oil Products Company, Chicago, who will report on methods of protection at the eighty-third convention of the American Chemical Society in New Orleans, March 28 to April 1.

Almost one-half the corrosion waste of the whole world occurs in this country, and represents over 1 per cent of the value of the nation's annual business, Dr. Egloff declares.

"The staggering cost of replacement of rusted or corroded parts of equipment in every industry is only a part of the damage entailed by corrosion, for the failure of a comparatively small rusted article may imperil an entire structure and hundreds of lives," Dr. Egloff explains.

"Yet iron and steel remain the outstanding structural materials in most industries and the rusting of iron is the foremost problem in metal corrosion. Other metals, too, are subjected to deterioration under given conditions, and the prevention or inhibition of corrosion is a prime requirements for solution of the problems of economy and efficiency.

"Workers engaged in the study of corrosion number into the thousands. Theories advanced to explain the rusting of iron alone would fill volumes, and remedies by the score have been proposed. Alloy steels containing chromium, silicon, nickel, copper, or tungsten, coatings of metal or of ceramic materials, paints, and bituminous coverings are a few of the remedies which have been used with some success. But the damage by corrosion continues, despite all these earnest endeavors."

The "How" and "Why" of the Throttling Calorimeter

By LAWRENCE WASHINGTON

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IT IS a curious fact that most of the books on steam engineering and power-plant testing, including the A.S.M.E. power test codes, tell us that the steam calorimeter is an instrument with which we may find the *quality of wet steam.*

This definition, although correct as far as it goes, does not tell the whole story. What the engineer is primarily interested in, and what he really finds with the calorimeter, is that property of steam that is variously known as the "total heat," the "heat content," or (to use a modern and less misleading name) the *enthalpy* of the steam. (Of enthalpy simply bear in mind that it means the same thing as "total heat" or "heat content.")

Having found the enthalpy, the engineer may then calculate the efficiency of the apparatus in which the steam is produced or used. For instance, the efficiency equation for a boiler involves the enthalpy of the incoming feed water and of the outgoing steam. If the steam is superheated, its enthalpy may of course be found directly from the superheated-steam tables or from the Mollier chart; if it is saturated, recourse must be had to some form of steam calorimeter.

Again, in finding the thermal efficiency of an engine or turbine, we must first determine the enthalpy of the entering steam, and if the steam is wet we must use a calorimeter.

These simple examples are given to show that it is the enthalpy and not the quality of the steam that we need to know. True, in some types of calorimeter, such as the separating, we must first compute the quality, and then use this value in calculating the enthalpy, by means of the conventional equation:

$$h = h_f + xh_{fg}$$

in which h = Enthalpy of wet steam
h_f = Enthalpy of the liquid, corresponding to the line pressure
h_{fg} = Enthalpy of evaporation at line pressure
x = Quality of steam in the line (decimal).

The symbols are those used in the 1930 Keenan (A.S.M.E.) steam tables, and all enthalpy quantities are in B.t.u. per lb.

However, if we use a throttling calorimeter we may find the enthalpy directly from the Mollier chart that accompanies the steam tables, without having first to calculate the quality.

The writer assumes that the reader is familiar with the design and operation of the standard types of steam calorimeter; if not, he may find good descriptions in the A.S.M.E Power Test Code, 1929 series, on "Instruments and Apparatus," Part II, "Determination of Quality of Steam."

To find the enthalpy directly from throttling-calorimeter readings and the Mollier chart, take the average exhaust pressure of the calorimeter, in pounds per square inch absolute, and the average superheat in the calorimeter exhaust, in degrees Fahrenheit. On the Mollier chart (of which a portion has been taken from the Keenan steam tables and reproduced in the accompanying figure) locate by interpolation between constant-pressure and constant-superheat lines the point 3, which corresponds to the calorimeter-exhaust pressure and superheat. Point 3, then, represents the state or condition of the steam as it leaves the calorimeter. The enthalpy may now be read by moving horizontally from the point 3 to the vertical scale of the Mollier diagram.

According to the theory of the throttling calorimeter, the enthalpy of the low-pressure steam exhausted from the calorimeter is the same as that of the high-pressure steam in the main line from which the sample is drawn; therefore, when we have determined the enthalpy of the calorimeter-exhaust steam, by the above method, we have at the same time found the enthalpy of the steam in the main line.

If, however, we should like to know the quality in the main line, for any reason, we may find this easily on the Mollier chart, by moving from point 3 to the left along a horizontal constant-enthalpy line, until we reach the main-line pressure. (Interpolation between constant-pressure lines may be necessary.)

The resulting intersection is the point 1, which represents the condition of the steam in the main line. We then find the initial moisture content by noting the position of point 1 with respect to the lines of constant moisture, which run approximately parallel to the saturation line and which are below this line. The quality, of course, is equal to 100 per cent minus the moisture content. Bear in mind, however, that it is really unnecessary to know the initial quality, so far as any subsequent efficiency calculations are concerned.

In the example shown in the figure, the data and results may be tabulated as follows, in the order of their determination, all pressure being in pounds per square inch absolute.

Steam-line pressure	155 lb.
Calorimeter-chamber pressure	15.5 lb.
Calorimeter-chamber temperature	264 deg.
Saturation temp. at 15.5 lb. pressure	215 deg.
Superheat in calorimeter exhaust	49 deg.
Enthalpy of steam	1,175 B.t.u. per lb
Initial moisture content	2.2 per cent
Initial quality	97.8 per cent

Note that the enthalpy and quality, as found from the Mollier diagram, are obtainable to as many significant

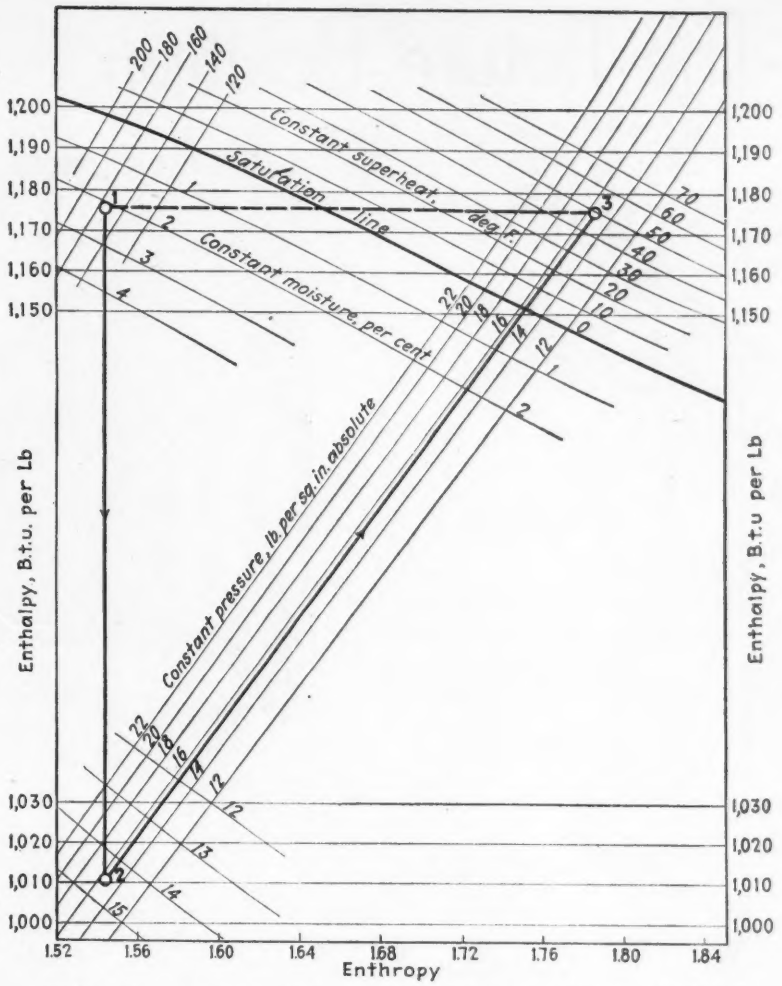
figures as those of the data, hence it is unnecessary to calculate the results by means of the usual calorimeter equations, unless the engineer wishes to do so to check his work on the Mollier chart.

Suppose that the steam in the line were superheated instead of wet. Could we find its enthalpy from the throttling-calorimeter readings? Surely; the only difference is that there would be a higher degree of superheat in the calorimeter exhaust.

The point 3 on the chart would be found as before, and the enthalpy read from the vertical scale. The horizontal line 1-3 would lie entirely above the saturation curve, in the "super-heat region," instead of crossing the saturation curve.

Common sense tells us, however, that in this case the calorimeter would be unnecessary, for by taking simply the steam-line pressure and temperature we could locate the point 1 on the chart and then read the enthalpy. This would give a more accurate result, too, than we could obtain with the calorimeter, for it would eliminate the small but inevitable heat loss from the calorimeter jacket and connecting pipe.

If, on the other hand, the steam in the line were very wet, an inspection of the Mollier diagram shows that the line 1-3 might then lie entirely below the saturation curve, in the "wet region." That is, the wet steam at the high initial pressure might not contain enough energy to evaporate all the moisture and to superheat the sample, upon expansion to the low pressure in the calorimeter. The data would then be insufficient to enable us to locate the point 3 which is needed for determining the enthalpy.



Mollier diagram gives enthalpy and initial dryness without calculation

Universal Calorimeter Needed for Very Wet Steam

This is so because the calorimeter-chamber temperature would then be that of saturation at the chamber pressure. When steam is saturated its temperature is governed entirely by its pressure and therefore the point 3 might lie anywhere below the saturation curve and along the constant-pressure line corresponding to the chamber pressure. Consequently, the throttling calorimeter is useless when the initial moisture content goes above a certain limiting value, and we must then resort to one of the other types, such as the separating or the universal calorimeter.

Although the process that takes place in the throttling calorimeter is frequently called a constant-enthalpy (or constant "total-heat") process, this does not mean that the enthalpy of the steam stays constant throughout the flow from inlet to exhaust. On the contrary, there is a marked change in all the properties of the steam, including its enthalpy, as it flows through the throttling orifice. Considering the orifice alone, we find that the flow through it is adiabatic and very nearly frictionless. The speed of flow, and therefore the kinetic energy, of the steam, increases enormously. As no heat is added, the increase in kinetic energy must be obtained at the expense of the enthalpy of the steam.

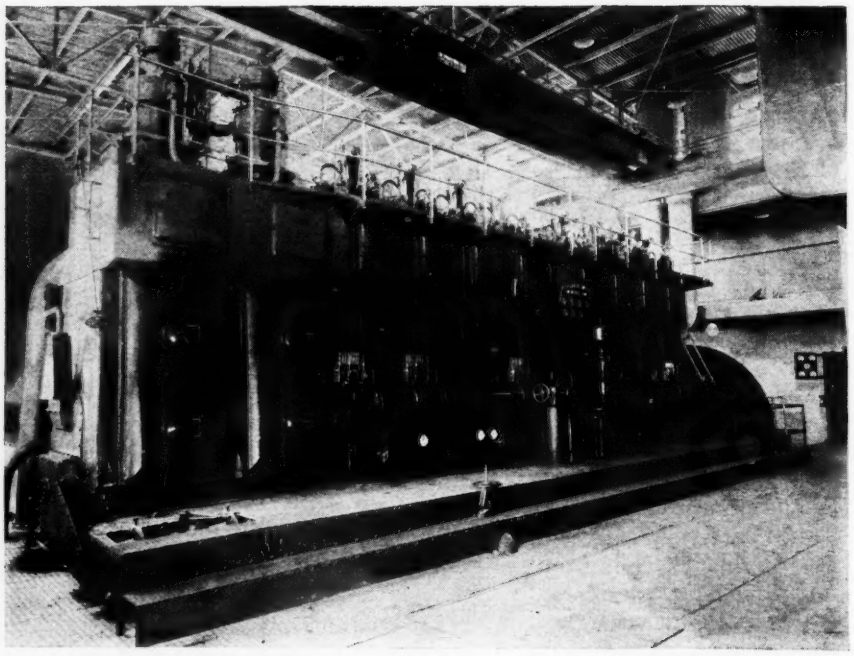
Taking the previously cited numerical example, and assuming that the flow through the orifice is absolutely frictionless, we may represent the change of conditions at the orifice by the vertical lines 1-2 on the Mollier diagram: Upon entering the orifice, the steam is at 155 lb. abs, with an enthalpy of 1,175 B.t.u. per pound and a moisture content of 2.2 per cent.

In a frictionless, adiabatic process the entropy does not change; consequently, the change of state of the steam is represented on the chart by a vertical line, starting at the point 1 and continuing downward until the exhaust pressure of 15.5 lb. per square inch absolute is reached. The resulting point 2 then represents the state of the steam as it emerges from the orifice into the expansion chamber. At this point its moisture content is about 14.5 per cent and its enthalpy about 1,010 B.t.u. per pound. The drop in enthalpy (1,175 — 1,010 = 165 B.t.u.) represents the energy required to produce the increase in kinetic energy.

The next and final process, whereby the enthalpy is restored to its initial value, takes place in the expansion chamber and is represented by the line 2-3. The kinetic energy, instead of being partly converted into mechanical work, as in a steam turbine, is here used up in churning the steam in the expansion chamber. Through molecular friction, the churning increases the internal energy of the steam, and also increases its "pv product," sufficiently so that if no heat were lost through the jacket and if the net change in velocity were zero, the final enthalpy would be equal to the initial value of 1,175 B.t.u. per pound.

The Future Position of the Diesel Engine

By OLIVER F. ALLEN
Consulting Engineer
New York City



A two-cycle, 2,400-hp. diesel in a plant of the Texas Louisiana Power Co.

This completes the series[1] of articles on diesel engines by Mr. Allen. In the series the increasing importance of the diesel for the generation of electric energy, both in central stations and industrial plants, as well as its use for transportation, is clearly indicated

AT THE New York Motor Boat Show in January a dozen makes of diesel engines were shown, varying in weight from 25 to 100 lb. per horsepower, all solid-injection, mostly four-stroke cycle, and with few exceptions embodying no new features. They represented the logical development of well-tried American, English, German and Scandanavian designs modified and refined to meet the needs of our expanding motor boat industry. More than half represented the growth of the internal-combustion engine industry, being by firms which have been in that field since the days of the first gas engines, associated with the early developments of gasoline automobile engines or of the diesel engines themselves since Dr. Diesel's early experiments. The types actually shown included some suitable for all classes of commercial and pleasure craft, for propulsion requirements up to over 1,000 hp. and for all classes of auxiliary services, even including complete automatic diesel-electric lighting and power plants for isolated land installations as well as for boats.

Three or four years ago only one or two diesels could be found at the Motor Boat Show and those not in a conspicuous location.

This feature of the diesel situation is mentioned because it emphasizes two important aspects of the diesel industry. First, a remarkable growth of public interest in and expansion of the utilization of this form of motive power. Second, the need of research and improvements in design, for, excepting a few minor refinements and a general improvement in appearance, the far greater number of engines shown this year were substantially like the few shown three, four and five years ago. In fact, many represented designs more than five years old which have simply been dressed up a little. Here and there advantage has been taken of improved metallurgy and a few gadgets added to simplify starting and control operations.

Brake mean effective pressures remain practically unchanged. Weights are generally excessive. Adequate means to prevent vibration are lacking.

It has taken nearly thirty years to bring the diesel to this state of perfection—thirty years of heart-breaking experimentation, but of indomitable hope, courage and skill, on the part of American, German, French and British engineers striving to bring the weight down from 450 lb. per horsepower to the present two and a half pounds. More than the prevention of fire is involved in the success now to be recorded. Aerial navigation may possibly be entering on a new phase. An airplane can travel 3,250 miles on cheap fuel, but only 2,484 miles on an equivalent charge of gasoline.

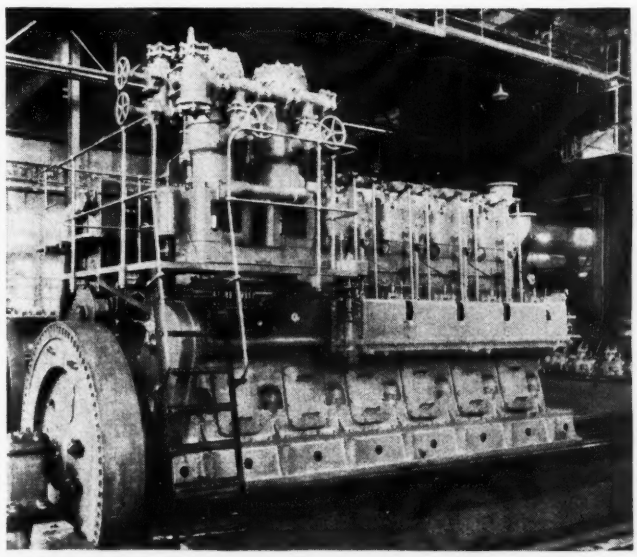
The preponderant display of diesels at the New York Motor Boat Show is another evidence that all classes of users of power, from the smallest to the biggest units,

[1]Other articles by Mr. Allen appeared in the following numbers of *Power:* Oct. 13, Oct. 27, Nov. 10, Dec. 1, Dec. 15, Dec. 29, 1931; Jan. 19, Feb. 2, Feb. 16, March 8, 1932.

are now "diesel-minded," and ready to be persuaded to buy, but they will not buy heavy, slow-speed, noisy old-fashioned engines.

With the market so evidently ready and with a large number of manufacturers equipped to make and sell diesel engines, the answer seems easy; just go ahead with sales promotion and get orders. But the solution is not that simple. Compared with the first cost of other prime movers, or with electric motor installations in the case of some land applications, the investment frequently has been excessive and has restricted sales. On the other hand, at the reduced prices of the last two years, marked down to meet the competitive situation, the manufacturers have found it difficult to get enough to cover bare manufacturing cost of the engines, let alone anything for new developments and profits. As no industry can give good service to its customers, make progress, or even continue to exist without carrying on development work, constantly improving the product and at the same time making a reasonable profit, the diesel engine situation is serious and deserves the attention and help of all power users. Reductions in power costs, marine, stationary and automotive, all have a direct bearing on the cost of living. Is there any more efficient means of effecting such reductions than increasing the availability, reliability and efficiency of oil engines with the direct and indirect influence on the whole power situation?

How can this be accomplished? By cooperative, constructive effort. The general public should realize more



Combined diesel-ammonia compressor of 235 hp.

and more that the diesel motor in all classes of transportation means greater safety, cleanliness and comfort and that in certain utilities and isolated plants its more general use would result in lower cost. Then they will ask for diesel-powered bus, railcars, motor boats and airplanes, while patronizing more department stores which share with their customers the economies of diesel power, like Harrod's in London, the Louvre in Paris and Macy's in New York.

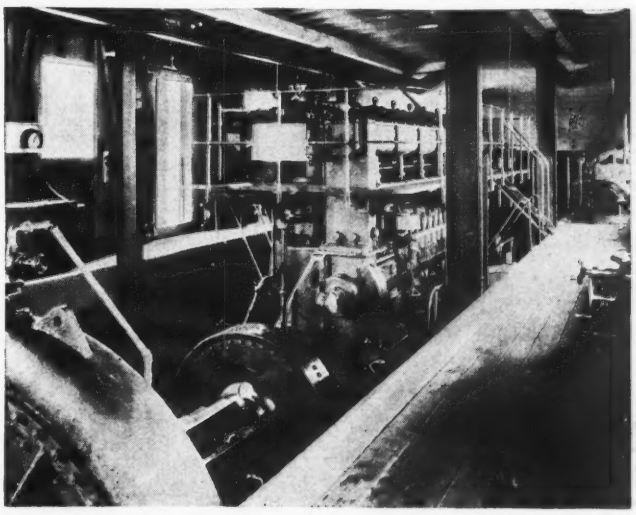
The user can cooperate by more intelligent selection so as to get not only a first class machine, but one suited to his particular conditions. He should not hesitate to pay a fair price for a good engine, nor be afraid to make a substantial investment so long as it can show a handsome return over a period of years. He should encourage the use of improved designs and control features. While seeking such automatic features as are feasible, he should supply adequate and intelligent supervision so that the engine he buys has a fair chance to give good service.

The consulting engineer can help, first by taking advantage of what the oil engine can do for his clients when its use is technically and economically justified, and second by encouraging the manufacturer to offer improved and more efficient types.

But after all it is the manufacturer who must carry the main burden. What can he do, more than he is doing? His is a very difficult problem, for with few or no profits for several years there are few reserves for research and development work, and for increasing and improving service facility, and little inducement to improve the quality and effectiveness of sales organization. While much has been said in this series of articles about the weakness of the diesel position in this country, and pointed reference has been made to some foreign accomplishments, it was not in criticism of our manufacturers, who have, to a considerable extent been the victims of circumstances beyond their control; rather it was to point out some of the things which need to be done to lift the industry out of its slough of despondency and put it on the high road to prosperity, along with the motor car and electrical industries. As a matter of fact our diesel manufacturers have some recent achievements of an outstanding character to their credit.

There has been too much unfair competition, which has shaken the purchaser's faith in diesels and at times demoralized the market. The men in the industry in administrative and commercial branches, as well as in technical and manufacturing departments, should know each other better and work more as a unit. An industry does not grow by simply increasing or even maintaining selling prices. The great examples of success in technical industry, as for instance, the incandescent electric lamp, show constantly improved product, constantly decreasing prices and steadily maintained profits.

The remarkably rapid growth in the use of engineering products such as automatic electric- and gas-operated household refrigerators, which are the result of extensive and thorough research combined with economical manufacture and effective sales policy, shows how responsive the public is to such products as adequately meet an existing, but perhaps almost unknown, need.



Diesel engine application on board a dredge

Europe is doing more than we are along these lines of research, new development, and reduced manufacturing costs. Yet our potential market is much greater; we should be taking the lead in cooperative action to improve the industry.

Technically, the diesel should be improved so as to secure smoother operation. Combustion should not only be controlled to avoid "knock" and excessive pressure peaks, but also to nearly double the brake mean effective pressures now general in this country. The selection and employment of metals, together with manufacturing procedure, should be improved so that stationary engines of 1,000 hp. and more should weigh between 100 and 150 lb. per horsepower and smaller units less than 100 pounds.

When well designed, it is believed that these lighter-weight, higher-speed engines can be produced at manufacturing costs so much below the present cost of slow-speed engines as to automatically eliminate the latter, at the same time insuring profits for the manufacturer and lower power costs for the user.

There is another aspect of the technical situation which must not be overlooked. The research and development necessary to accomplish the improvements just outlined involves the solution of many problems in mathematics, physics, chemistry and metallurgy which are, generally speaking, beyond the facilities of the engine manufacturer's organization and which frequently also interests other industries. Such problems are being studied by the staffs and in the laboratories of technical schools and universities, such as Pennsylvania State College, Massachusetts Institute of Technology and Columbia University, and by the engineering societies, especially as related to oil engines, by the A.S.M.E. and the S.A.E. The characteristics of both fuel and lubricating oils are of prime importance, and the refinery interests are cooperating to meet the growing needs of the oil engine users. The Oil and Gas Power Division of the A.S.M.E. is coordinating many of these endeavors. The universities, technical schools and engineering societies thus aiding the industry should be cordially and liberally supported, not only by those within the industry but by those outside who will benefit by improved and cheaper power.

It requires no stretch of the imagination to see the present American diesel engine production of 200,000 hp. per annum grow in the next five years to five times that figure when one considers the remarkable expansion of applications during the past two years and the real need for diesel power on land, at sea and in the air. Shall we all get together to bring this about?

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A Tankless Ice-Making System

By R. S. WHEATON*

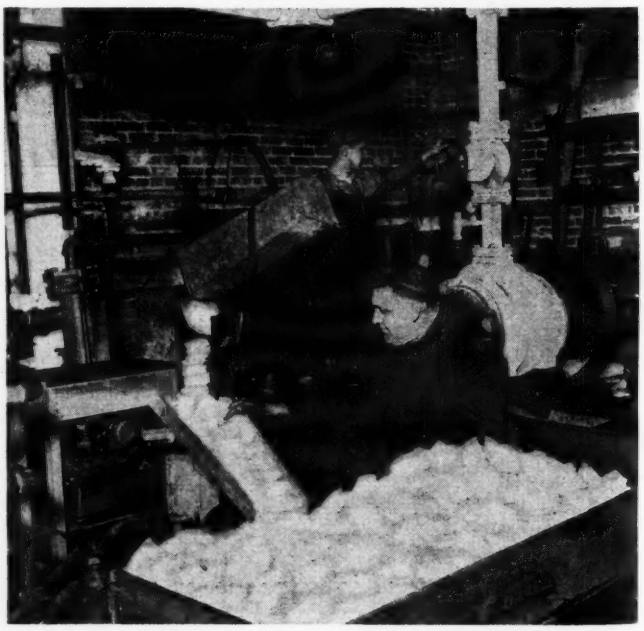
WITH the intention of eliminating the expensive ice can tank the "Pak Ice" machine (briefly mentioned in the Nov. 3, 1931, number of *Power*) was developed and is now in commercial use.

It consists, essentially, of a corrugated liner fitted inside of an outer jacket. Ammonia is introduced into the space between the outer jacket and the cylinder liner and water is circulated through the liner, with the result that the evaporation of the ammonia in the jacket freezes a part of the water upon the fins. A set of scraper blades fastened to a rotor mounted on a shaft, which is carried in two bearings at the ends of the liner, is made to revolve inside of the liner. The scraper blades remove the ice from the corrugated liner as it is formed; the ice is not allowed to become any thicker than 0.008 inch.

A centrifugal action is set up by the rotor and the scraper blades which throws the water against the liner, and the ice as it is removed from the liner faces, being lighter than water, is forced to the center of the liner. The water which has not been frozen is continually recirculated through the machine and carries the frozen particles out of the machine. Make-up water is added in accordance with the amount of ice that is frozen out of the circulating water stream.

With this construction there is a high heat transfer from water to liquid ammonia, for it is a well-known fact that the highest rate is obtained when the heat passes from a liquid to an evaporating liquid. The thinness of the metal walls separating the two liquids increases the action. These thin walls can be employed in this machine because the corrugated construction of the liner results in great strength. In this machine there is a rate of flow of the water of 18 ft. per second washing over the liner faces, which also insures a high heat transfer rate.

The ammonia surrounding the liner is supplied by a conventional accumulator arrangement, and as it is boil-



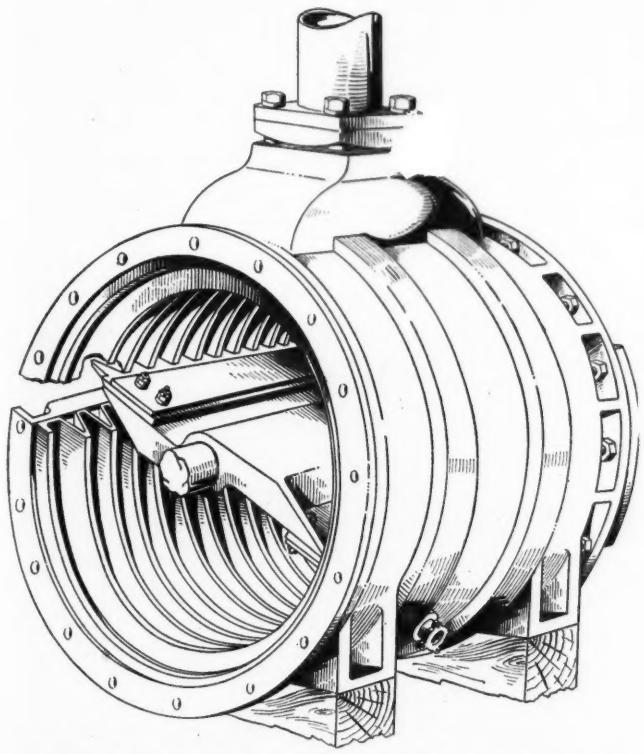
Making brequettes of "Pak Ice" crystals

*Vilter Manufacturing Company, Milwaukee, Wis.

ing violently there is a constant natural circulation of the ammonia. Turbulence is secured by means of the longitudinal ribs built in the outer jacket, which cause the ammonia to be thrown up into the corrugations built in the liner.

In the ordinary can ice-making plant the time of freezing, say 36 to 40 hr., is due to the resistance set up by the ice forming along the surface of the metal can. The first quarter inch freezes in a few minutes, whereas the final inch of can requires hours. In this machine the ice flakes do not reach a thickness of over 0.008 in., which eliminates the insulating effect.

The sum total of all these things is that a machine only 40 in. in diameter and 46 in. long over-all has a capacity of 25 tons of ice per 24 hr. Comparing this to a conventional ice-making tank of the same capacity, there would be required a tank 50 ft. long, 20 ft. wide and 45 ft. deep



View of the "Pak Ice" machine, showing the snow scrapers

containing three hundred and sixty 300-lb. ice cans to make an equivalent production of ice. The power requirements to operate the cutter knives and the circulating water stream in the machine do not exceed 13 hp., which can be compared to two 3-hp. brine agitators or the ice crusher, plus the labor cost of harvesting the ice from an ice tank.

The ice snow coming from the machine can be spouted wherever desired and the unfrozen water conducted back, for the snow deposits readily separate out of the water stream.

One fact sometimes overlooked is that heat radiation losses from an ice-making tank amount to 20 per cent of the refrigerating load. These losses are eliminated almost completely by the small insulated surface of a "Pak Ice" machine.

The applications of this new ice-making machine seem to have many ramifications. A brine ice can be made having a eutectic point of —6 deg. F., which is ideal for the packing of ice cream. As shown in the photograph, the snow can be spouted into a briquette machine, recently developed, which will make briquettes by the regelation process into any conventional size, usually ½-lb. cakes. These are ideal for icing refrigerator cars, space cooling and even for placing in household refrigerators. The briquettes are of a rather peculiar formation in that they are made with curved surfaces in such a manner that there are but few points of contact, which is done to prevent their freezing into a solid mass of ice. In railroad car icing it is desired to spout the ice into the bunkers of the refrigerator cars; due to the peculiar formation of the briquettes it is possible to store them in bins held at 27 deg. F. 30 ft. deep without the briquettes freezing into a solid mass. When the trap door is opened at the bottom of the bin the briquettes will spout out much in the manner that coal briquettes can be spouted, which, of course, eliminates the conventional method of handling.

Another field of application which holds great promise is in the chemical industries. It has been demonstrated that a solution of Glauber's salts can be run through the machine and the salts are precipitated out and recovered from the circulating stream of the solution in the same manner as the water snow is made.

Information is not yet available as to the entire feasibility of using this equipment for the precipitation of paraffines and waxes out of high-grade automotive lubricating oils. It is believed, however, that with a slight modification of the design, this can be accomplished.

The ice manufacturer should be interested in this machine as being a means of increasing his production without adding to his tank room size. By the simple expedient of placing "Pak Ice" in an ice can, the mass will freeze solid in 12 hr. as compared to the conventional 40 hr. required in ordinary practice. Of course, the ice is not clear, but there are many applications of ice where this does not make any difference. The small space requirements of the machine is possibly the most important economic factor concerning the equipment.

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Storing Sawdust Fuel

GREEN SAWDUST for heating purposes may be stored under cover for periods up to one year with so little loss in heating value as to make storage quite feasible and practical.

On the other hand, open storage of sawdust for two years or more is not practicable. Even one winter in the open results in such increase of moisture content as to reduce heat value materially.

Such are the findings from a study of British Columbia sawdusts for domestic and commercial heating, conducted in the Canadian Forest Products Laboratory at University of British Columbia, Vancouver, results of which have been published in a report from the Forest Service, Department of Interior, Ottawa.

Douglas fir sawdust is the most satisfactory of the species available from coast lumber mills. High moisture content of Western hemlock greatly reduces its heating value, while the high heat value of Western red cedar is more than offset by the small weight of material per unit.

Sawdust from the mills for heating purposes is not sold by weight but by volume in "units" averaging 200 cu.ft. The weight of a "unit" varies from 1½ to 2½ tons, depending on the species and moisture content.

The Responsibility of Mechanical Engineers In Smoke Abatement

By COL. ELLIOTT H. WHITLOCK
Research Professor at Stephens Institute

Presented here are excerpts from a talk given by Colonel Whitlock before a recent meeting of the A.S.M.E. in New York, in which he laid stress on the importance of correct combustion equipment to eliminate solid carbon in the stack gases and to save money for the owner

TO THE general public any visible discharge from a chimney or stack is smoke, but to the scientist such discharges may be termed dust, cloud, fume, or smoke, depending on the size of the particles in the gas stream.

The smoke that is annoying the public is caused, with but few exceptions, by the incomplete combustion of fuel and carries with it enough carbon to color the stream black or gray as it leaves the chimney. The problem of eliminating such smoke may be called *the equipment problem.*

Other problems are the *fly-ash problem* and *the sulphur problem.*

Let us consider these in the reverse order. Little is known at present about the sulphur gases formed during combustion and still less about any practical way to get rid of them after they have been formed, or of the preparation of the raw fuels to reduce the sulphur content prior to combustion. It is encouraging to know, however, that some research work is being done on this problem and that some practical experiments have been tried. The latter have been very costly and as yet are far from proving commercially successful. The solution of this part of the problem, then, is one of the responsibilities of the mechanical engineer.

The fly-ash problem, too, is a challenge to the engineer. While more progress has been made in this than with the removal of sulphur gases, no solution that will give satisfactory results with a reasonable investment has been attained. The removal of solid particles, especially the very fine particles, from large volumes of hot stack gases can best be done at the present time by electrical precipitation. The cyclone method has achieved some success, and studies have indicated that further improvements may be expected along these lines.

The so-called "cinder trap" is another design based on the idea that the momentum of the particle will free it from the gas stream when the stream is made to change

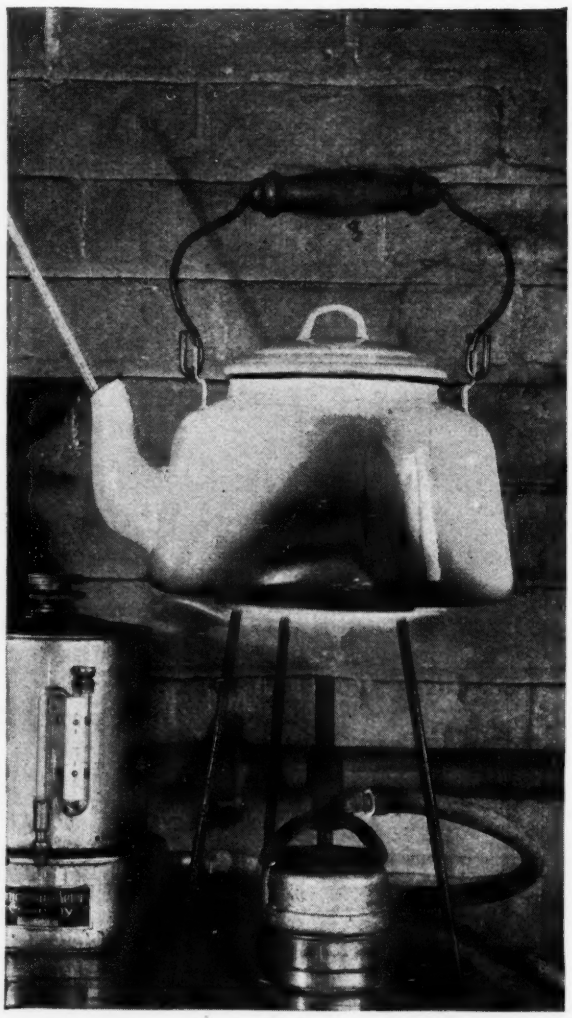

Fig. 1—Flame close—soot forms on kettle —5 min. required to heat water to boiling

its direction. However, here too, as with the cyclone, much of the fines pass through. Bag filtration is seldom considered for stack gases, because the temperature is too high.

This brings us to what I have termed the equipment problem. Here the engineer has already attained definite knowledge that will permit designing fuel-burning equipment to satisfy the requirements for complete combustion of any fuel.

Referring to the equipment problem, we know that it is wasteful and expensive to maintain conditions of poor combustion. We also know that the cost of remodeling the equipment to improve such conditions will net handsome profits on the investment.

Having then brought this part of our problem to the conclusion that smoke can be eliminated, should we not ask ourselves another question? Has the engineer fulfilled his commission by having solved the equipment problem or does his responsibility carry on to the end that provides for the installation of nothing but correct equipment? I am convinced from my experience as Smoke Commissioner of the city of Cleveland that the most constructive work to be done is to regulate the installation of *all* new fuel burning equipment.

Perhaps this may savor of government regulation, but, if it does, all I have to say is that it worked and is still working in Cleveland and is also working in other cities where smoke abatement is taken seriously.

The guardians of our pure water supply are engineers and are unmolested by political changes. Why, therefore, should not the guardians of our air supply be established on a similar general basis?

Try This on Your Tea Kettle

It's simple "common sense" that a tea kettle will heat faster if the burner is placed close, but it doesn't happen to be so, most housewives and some engineers to the contrary. To prove it, and also to show that close flame means smoke, Colonel Whitlock put the bunsen burner in two positions, as shown, using the same adjustment and gas flow in both. With the close flame, (Fig. 1), it took five minutes to heat the water to boiling and the kettle was covered with soot. Fig. 2 shows what happened with more spacing

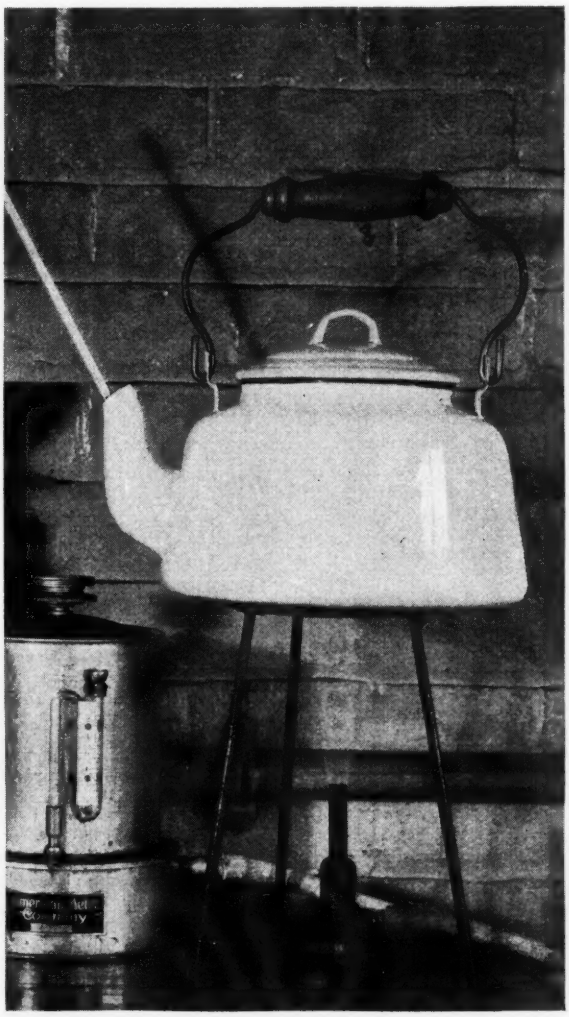

Fig. 2 — Lowering of burner permits complete combustion, eliminates soot deposit and permits heating of water to boiling in 3½ min.

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Watt-Hour Meter and Lamps As Phase-Rotation Indicator

By L. W. WYSS

AT AN ISOLATED SUBSTATION it was necessary to know the phase rotation of the 13,800-volt station bus. No motor or phase-rotation indicator being available, lamps were connected to the potential transformer leads and wattmeter to obtain the phase rotation, as shown in the diagram. This connection is identical to that used in making a portable phase-rotation indicator, using a re-

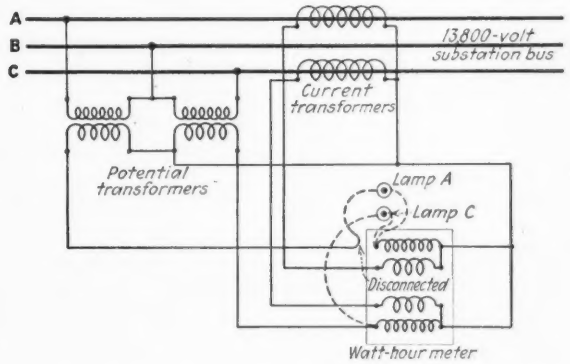


Diagram of connection for using lamps and watt-hour meter to show phase rotation

actor and two lamps. The rule is to assume that if lamp *A* is bright it indicates that the phase rotation is *A, B, C*, while if lamp *C* is bright the phase rotation is *C, B, A*.

A portable instrument is preferable for checking the phase rotation, but it may prove advantageous at times to know that wherever there is available an alternating-current watt-hour meter and two lamps a reliable substitute for a phase-rotation indicator can be made in a few minutes.

Air Preheaters

As seen by the operator

By JAMES F. MUIR
Montaup Electric Company

THE AIR PREHEATER has become thoroughly established as one of the principal appurtenances of the boiler unit. Moreover, it can be pointed out that as an adjunct of the combustion system it has, in a few short years, marched right on into the front line of importance of the boiler plant, and in pulverized-coal installations it has, in some cases, actually shaded the glory of the boiler by claiming almost 50 per cent of the heating surface of the steam-generating unit. To demonstrate, also, its economic status it has, in a number of instances succeeded in pushing the economizer clear out of the picture.

Saves 5 to 10 Per Cent of Fuel

Economic studies have shown that the preheater increases the efficiency of the firing equipment, the boiler and the superheater and the steaming capacity. It reduces the loss in combustible and makes possible heat liberations as high as 80,000 B.t.u. per hour per cubic foot of furnace volume and with fuel savings of 5 to 10 per cent. All of these favorable factors are made available by heating surface which is obtainable for about 20 and 30 per cent of the cost of boiler and economizer surface. Savings of this order are, of course, too large to be overlooked by designers and operators.

Air preheaters save a lot of money by heat recovery. They also are sometimes a source of trouble. Everybody wants to know how to get the benefits without the grief. Here are some practical suggestions from the operating viewpoint

A lot has been written in the engineering journals, therefore, glorifying, more or less, this heat-recovery equipment, and rightly so, because it is doing wonderful work and in pulverized-coal and gas fuel installations it is, in general, living up to its reputation. As a matter of fact we might be led to believe that it is the "last word" in power plant equipment.

Corrosion and Plugging

Unfortunately, corrosion and plugging are two well-known demons that are running wild all around the "box of tricks" and playing havoc with the tubes or plates, especially if the gases come from an oil-fired furnace. These two devils just love oil firing, they thrive on it. As soon as they are cleared out of one tube they pop up in another and all through the year they play tag with the operators, but they are never caught or demolished.

The discouraged operator asks: how did these ghost-like destroyers get going in the first place? Why! they are offsprings of the sulphur and hydrogen in the fuel, and low gas temperatures give them vim and vigor. But, could not the equipment be designed in such a way that the place would be uninhabitable for the ubiquitous pests? Could it not be made too hot for them, not in spots but uniformly hot all over?

Maybe the answer is that the designers of power stations and preheater equipment have been so anxious to save B.t.u.'s and first cost that they have overlooked two formidable combatants, namely, gas distribution and air distribution. Not only have these important factors been neglected, but apparatus provided for cleaning heating surface, usually steam jets, actually promotes corrosion by coating the surfaces with moisture; Moreover, the jets are, in most cases, unsatisfactory as an agency for removal of soot, scale and chemical compounds.

The preheater manufacturer may testify that poor distribution of air and gas is traceable to the design of the ducts connected to and outside the operating zone of the preheater.

The outline of the duct is governed by the accommodation available for its installation and the size or area of the connection attached to the preheater, these corresponding to the openings in the preheater casing. The contour or shape of the duct approaching the heater may not agree with the most suitable dimensions to give uniform flow or minimum friction loss, but these factors are of little consequence, since distribution after the air or gas reaches the preheater depends on tube size, tube or plate spacing, arrangement of tube banks, or plate units, location of baffles and dampers.

In actual operation the gas and the air will not travel as intended; it will take the shortest path, the coldest or the hottest route, but it will not go through the unit uniformly with the designs of tube and plate preheaters as now installed.

Is it possible that distribution cannot be controlled, or

is the designer not particularly interested in this operating feature? So long as low transfer rates are acceptable and the amount of surface specified or recommended is liberal, so much so in fact that relatively satisfactory economic results can be obtained with a large percentage of the surface inactive, there seems no particular urge or necessity to dig into questions of distribution of gases or cleaning.

Guide Vanes Might Help

The ventilating expert uses diffusers, auxiliary dampers, switch dampers and guide vanes to direct the flow and control the quantity and velocity of air to certain locations and outlets. Perhaps it would be a good idea to look over his stock in trade and apply some of his ideas to the preheater. Guide vanes might to some extent overcome stratification and laning, and dampers of special design could possible be installed in the gas pass to sectionalize, rather than bypass, the heater, so that only a part of the surface would be used at low ratings.

The vertical tube-type two-pass preheater is usually provided with a horizontal baffle located at the center of the unit. It is just possible that plugging and corrosion, which occurs to the greatest extent at the air inlet, could be retarded by placing the inlet end of the baffle lower down in order to increase the area of the air inlet. The entrance velocity of the air would be lower, the temperature of the first few rows of tubes would consequently be higher and more work would be done away from the air inlet.

The velocity of the air at the outlet would be increased, which would be an advantage, since the temperature difference of air and gas at that point would be less. The disadvantage would be a slight increase in draft. Something might be saved in maintenance cost and performance, therefore, by giving some consideration to the location of the baffle.

Why Not Horizontal Tubes?

The popular tubular preheater design consists of vertical tubes with gas flowing through the tubes. Units built with horizontal tubes, however, with gas flowing upward across the outer tube surface, give satisfactory results. With the latter type corrosion is not any greater, efficiency is just as high, surfaces exposed to the gas can be cleaned with an air lance and plugging of tubes (the most persistent trouble of all) is entirely eliminated. The first cost is slightly higher, but greater reliability, lower draft loss and lower maintenance more than offset this only disadvantage. A review of operating experience with both types might warrant a more extensive application in the central station of the horizontal tube design, which is used largely in the industrial field.

Non-Corrosive Alloys

The practical limit of cooling with the preheater is the dew point of the gases. The actual dew point may be 200 deg. or lower, but owing to the difficulty of obtaining uniform distribution and to prevent excessive corrosion and clogging it is necessary in certain plants to maintain gas outlet temperatures of 300 deg. F. and over. Even this may not represent the true temperature, because the gas is cooled to a considerable extent by leakage of cold air through corroded tubes and imperfect joints.

It has been suggested that in time non-corrosive alloys for tubes and plates will be used so that exit temperatures below the dew point can be utilized. This plan would of course increase efficiency, but the advantage would be offset by higher first cost and the preheater would be in a less favorable economic position. Clogging would in all probability be greater with operation at the lower gas temperatures.

The compounding of an alloy suitable for tubing and sheets and one that will resist the ravages of sulphuric acid, which may be anything from practically pure to weak dilute, at reasonable cost, has not yet been accomplished. We must look therefore to physical changes in the assembly of the unit for early improvement in performance and maintenance.

Dirt Increases Fan Load

The inability to maintain clean tubes and passages has an important effect on auxiliary power and fan capacity. The capacity of the forced- and induced-draft fans is based on the draft loss through the boiler, economizer, preheater, air ducts and flues, and the quantity of air and combustion products to be handled for maximum fuel consumption, plus a margin of safety of from 25 to 100 per cent.

This margin depends, to some extent, on the familiarity of the designing engineer with preheater operation. With clean preheaters and normal leakage the fans provided in most cases have ample capacity for the maximum heat liberation rate for which the furnace is designed. As the heaters become coated with soot and scale, steam generation gradually decreases until the point may be reached when fan power is at maximum while the boiler is considerably below normal capacity. In a large number of stations boiler output is assumed to be limited by fan capacity, when actually in most cases the operating condition of the preheater is the factor governing steam generating capacity.

Where spare boilers are available the situation is more simple and favorable conditions can be maintained conveniently by switching from one boiler to another. In stations, however, where energy demand requires maximum output of boilers at all times, the preheater situation may be serious and under certain aspects the installation of additional boiler capacity might be warranted on account of preheater operating limitations.

Steam Jets May Aggravate Trouble

Certain things, good, bad and indifferent, have been done to keep ahead of the game. Sand blasting is used instead of steam jets. In some cases tubes have been removed and air lanes provided, like steam lanes in a condenser, in an effort to raise the temperature of the tubes at the cold end, because the hotter the tubes the less will be corrosion and clogging. Bypasses have been provided for air and gas for use during low load periods. In some oil firing installations a quantity of air is bypassed at all ratings. In other instances a part of the heated air is recirculated, which of course requires more fan power and results in loss of efficiency.

Where clogging is particularly bad, maintenance schedules call for replacement of plugged tubes rather than attempting to clear them while in the preheater. Tubes removed are reamed out, sand-blasted and placed in stock and used for subsequent replacement. Individual tubes are tested for leakage with compressed air. Further maintenance activities include: washing tubes with high-pressure water jets; dusting tubes with soda ash after washing; washing with water to which has

been added soda; painting surfaces with paint of high alkalinity. All of these operations are intended to overcome operating troubles, reduce maintenance and improve performance, although in most cases the methods employed have been given up after a short trial.

The accepted trend in power plant design is toward large boiler units; in fact, one boiler for one turbine-generator is now considered a satisfactory division of steam and electric generating equipment. For plants with preheaters, and designed for fuel of high sulphur and hydrogen content, this equal proportion of units would seem to involve too great a risk of interruption in steam generation. The boiler and superheater may be as reliable as any turbine-generator, but when a boiler must live with a preheater appendix which suffers most of the time from adhesions and bad circulation the entire unit may have to go into the "hospital" at any time.

These somewhat pessimistic observations on preheaters are not intended to be obstructive, but they are offered primarily to emphasize the need for a more thorough consideration of operating factors and the necessity for incorporating in designs means which will result in uniform distribution and better control of the gases, and to call the attention of all concerned to poor performance and loss in boiler capacity.

It might be well also to add a word of caution regarding the use of preheater performance guarantees in making economic studies of combustion systems. Guarantees are usually based on heating surface that is assumed to be substantially free from soot or other products carried by the gas. This condition actually never exists, because coating of tubes and plates occurs, to a major extent, when starting up the furnace. It is necessary, therefore, to establish a fair average performance by investigating the records of installations already in operation.

▼ ▼ ▼

Locating the Weak Spots In Transformer Insulation

HOW WELL high-voltage power-transformer windings will stand up against lightning and other transient surges is usually determined by a surge test. Even when the windings withstand a high-voltage surge test that causes the bushings to flash over, as in Fig. 1, it is not proof that there has not been an incipient failure between turns in the windings. An incipient failure may not show up for several months after the transformer has gone into service, when it happens to be subjected to a high-voltage surge due to lightning or other transient conditions in the system. Under these conditions when the surge produces a discharge between turns the current follows in the path and causes a bad turnout in the windings.

The satisfactory test on a transformer is one that will duplicate operating conditions. This has been accomplished by the Westinghouse Electric & Manufacturing Company by having the transformer's windings excited at the peak of the power voltage wave when the surge test is applied. This is known as the combination power and surge test. Fig. 2 shows a transformer subjected to such a test. The surge voltage flashed over the right-hand bushing and the 60-cycle power maintained the arc over—proof that the transformer withstood the surge voltage. With this test the power current will follow any winding failure produced by a surge that would be likely to cause trouble in service. On these tests the bushings were intentionally flashed over to give a visual conception of what would occur inside the tank if the winding haev failed. Normally in a test of this kind the bushings are protected against flashover by a gap set below the flashover value of the bushings.

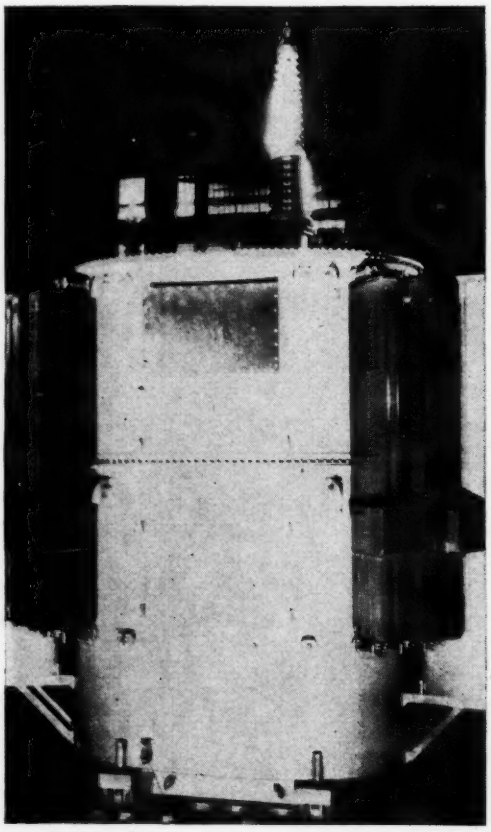


Fig. 1—Ordinary surge test produces a momentary flashover on the bushing as shown

Fig. 2—Combination surge and power test, the 60-cycle power caused the arc shown when the bushing flashed over on the surge test

PRACTICAL AIDS TO OPERATION

Adjusting Maximum Demand to Suit Load Requirements

IN THE PLANT with which I am connected the problem of limiting the peak load during slack manufacturing periods came up. Power is purchased on a maximum-demand basis, the highest demand for any ten minutes in a month determining the demand charge for that month.

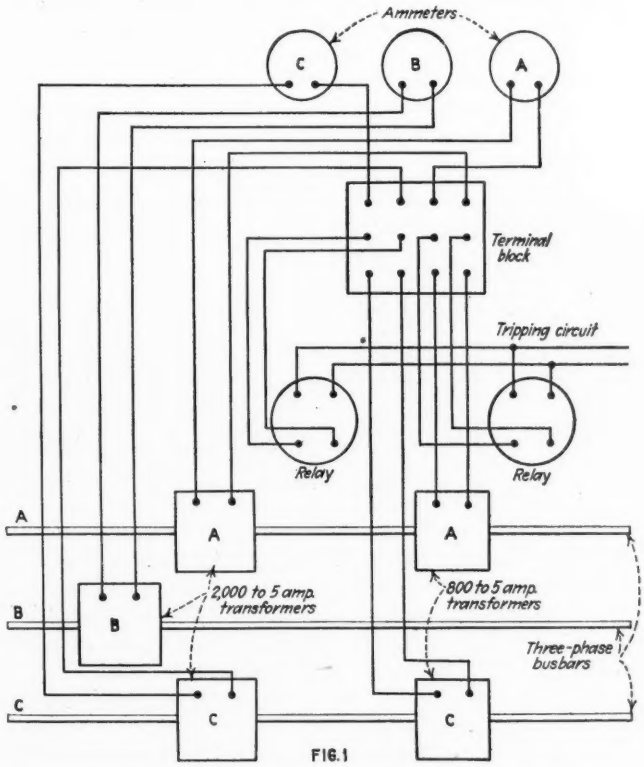
Connected in the busbars on the main switchboard are three 2,000- to 5-amp. current transformers, one in each phase, as in Fig. 1. Three ammeters are connected to the transformers to indicate the total current. Phases *A* and *C* also had time-limit induction-type overload relays connected in series with the ammeters. These relays were used to operate the tripping circuit of a demand-limit device and would switch off electric ovens and certain motor loads when a predetermined demand had been reached. The lowest limit with this equipment was 800 amp., but because of reduced production it was advisable to keep the demand within 500 amperes.

Two 800- to 5-amp. current transformers were available and these were installed in the busbars, as in Fig. 1, in addition to the three 2,000- to 5-amp. transformers. It was necessary to leave the latter in circuit because the ammeters were calibrated to them.

A fiber terminal board was constructed with twelve studs and six movable links. This board was mounted back of the instrument panel and wired so that three combinations of connections are possible by changing the position of the links, as in Figs. 2 to 4. The ammeters were wired permanently in the circuit of the 2,000- to 5-amp. transformers.

In Fig. 2 the links on the terminal board are arranged so that the relays are connected in series with the ammeters on the 2,000- to 5-amp. transformers and the secondaries of the 800- to 5-amp. transformers are short circuited. With the terminals connected as in Fig. 3 the ammeters are connected to the 2,000- to 5-amp. transformers and the relays to the 800- to 5-amp. transformers. The position of the links, Fig. 4, connect the ammeters to the large transformers only, the relays are cut out of circuit and the terminals of the small transformers are bridged. The new arrangement of transformers and the terminal board makes it possible to set the relays to trip at 200 amp. if necessary. When normal load conditions obtain again the tripping limit can be increased as occasion demands.

Toronto, Ont. ELLIS MILLS.



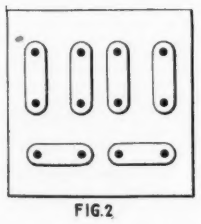


FIG.2

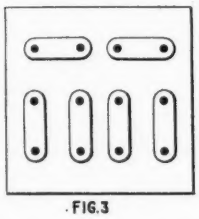


FIG.3

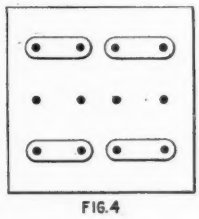


FIG.4

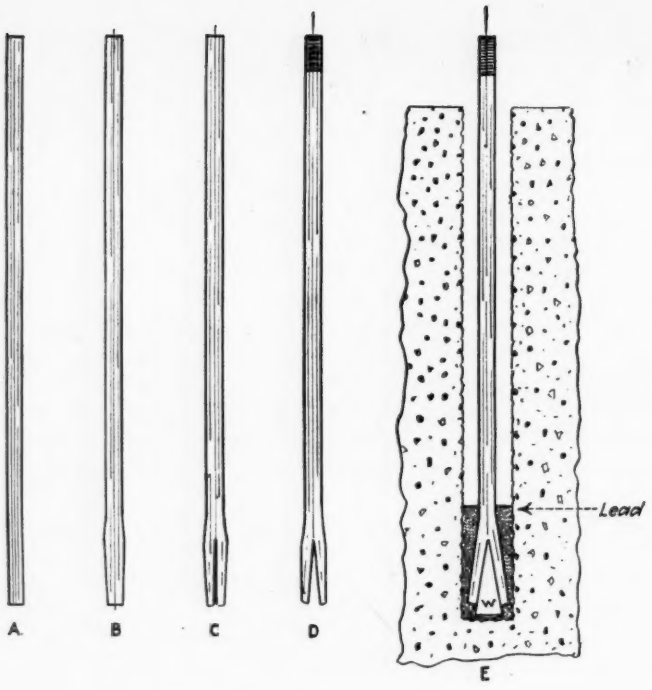
Figs. 1 to 4—Diagrams of meter and transformer wiring and terminal board connections

Foundation Bolts for Compressor

SEVERAL years ago I found it necessary to install a 12x24-in. horizontal ammonia compressor which was directly connected to a corliss engine. This unit was to set on solid concrete to a depth of about 5 ft. My problem was to bolt it down so there would not be any movement of the bedplate.

After considering various schemes for the $1\frac{1}{2}$-in. foundation bolts, I finally decided on making them as shown by sketch. *A* is a $1\frac{1}{2}$-in. round iron bar of the required length; *B* is the same bar with the end upset. *C* shows the upset end split, *D* the split end partly opened, and *W* the wedges cut out of a 2x2-in. square bar.

After we had laid out the bolts in their respective places we drilled 4-in. holes to the required depth. If there was any sign of moisture in the holes they were dried out thoroughly. We next heated up the split ends to a red heat, with the wedges inserted, pushed the split end down into the hole, and after it reached the bottom, gave the top of the bolt one or two blows with a mallet, which forced the wedge upward and spread the split ends. While the bolt was still hot molten lead was poured down the hole until the upset portion of the bolt was completely covered as shown at *E*. After the lead was cold a steel bar was used to ram the lead solidly. When the bolts were all in place the machinery was set up, leveled and grouted in. The grouting mixture ran in and filled up all the holes above the lead.

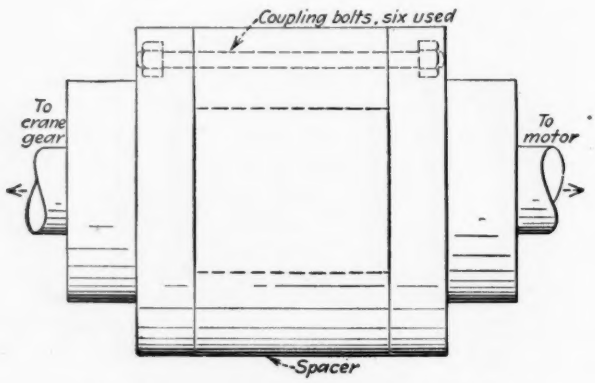


Steps in placing foundation bolts

This set has been in operation for the past fourteen years, and today there is no sign of movement nor working along the foundation line. A. C. GIGER.
Vancouver, B.C.

Crane Motor Replaced by One of a Different Type

ALTHOUGH it is generally possible to have on hand a spare rotor or stator, or better a complete motor for important machines, often even in well equipped plants, none of these are made available. The management assuming that any repairs to machinery can be made when the equipment is not operating, such as nights or Sundays. Granting that this operating procedure may work satisfactorily in some places, only recently I had an experience where this arrangement failed. The brake on a heavily loaded crane failed to hold and the load was lowered so fast that the motor reached a speed where the bands came off the armature, allowing the coils to come out of the slots and jam between the armature core and the pole-pieces. In addition to this the rear bearing end-bell was cracked almost completely around the bolt circle. To make repairs would take at least several days but the crane had to go into service again as soon as possible. Another crane motor of the same make but not of the same type was borrowed from a repair shop and after considerable mechanical juggling the motor was mounted on the crane.



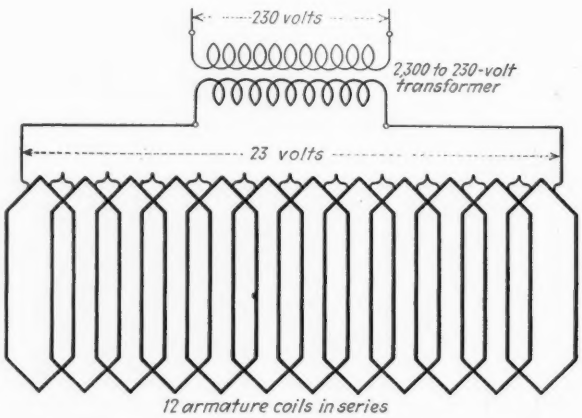
Spacer between motor and crane coupling

To do this it was necessary to place the motor so the coupling halves were separated about 5 in. between their faces. This space was filled with a dutchman as in the figure, about 9 in. in diameter made from an old coupling found on the scrap pile. Bolt holes in this spacer were laid off from the motor coupling and $\frac{1}{32}$ in. clearance allowed for the bolts.

As the motor's speed was only 850 r.p.m. the heavy coupling operated satisfactorily until the other motor was repaired. Although this installation is not good practice it eliminated a costly shutdown and even though the coupling did not have the strength for permanent use it transmitted 40 hp. for several 24-hr. shifts satisfactorily.
Tarrant, Ala. G. H. EMERSON.

Drying Out Armature Coils With a Transformer

FAILURE of nine armature coils in a vertical hydro-electric generator made it necessary to dry out spare coils that were available in storage for immediate replacement. Normal current in these coils was 255 amp., and it was desirable to circulate sufficient current in them to dry them out. To supply this current a low voltage was obtained by using a spare 25-kva., 2,300- to 230-volt power transformer. The 2,300-volt winding was connected to the 230-volt bus and the 230-volt winding of the transformer was connected to 12 spare armature coils in series, as in the diagram, which have about 23 volts across the coils.



Transformer connected to armature coils to supply heating current

A current of 125 amp. was obtained in this way, which overloaded the transformer about 16 per cent. This provided ample heat for the coils, since they were not subjected to forced air circulation, as when in a machine. The coils were also covered with canvas to conserve the heat and help maintain a proper temperature. A period of 48 hr. was required to do the drying.

The use of the transformer to supply 10 per cent of its rated voltage is another example of how electrical equipment may be used to hold out in an emergency.
Iron Mountain, Mich. L. W. WYSS.

CURRENT COMMENT

Avoiding Complicated Valve Arrangement

IN THE March 1 number of *Power* H. M. Spring describes a way of avoiding complicated valve arrangement on emergency stand-by equipment, such as boiler feed or fire pumps, diesel engines, air compressors or other machines that are started and stopped frequently on short notice, by adjusting all the small valves in the branch lines leading to oil cooler, bearings, gland seal and other points of distribution to pass the proper amount of water and screwing down the packing nuts to hold them in this position. Then a master valve is placed in the supply main at a convenient point so it can be opened quickly when starting up, thus eliminating the necessity of adjusting each individual valve.

This arrangement is very convenient for the operator, but it leads to negligence and should be made foolproof.

Mr. Spring depends entirely on the packing glands to hold the small valves in proper adjustment. A much better and safer way that has proved satisfactory on many installations is to slot either the disk or seat ring of the small valves to pass the minimum amount of water required when they are closed tight. The same result can be obtained if gate valves are used by drilling small holes through the wedge gates.

This method eliminates the possibiliy of one of the small valves being accidently turned off and not being noticed by the operator. RAYMOND SEPTOR.

South Amboy, N. J.

Economical Power-Factor Improvement

WHEN ANSWERING the question by O. R. in the Jan. 19 number, it must be kept in mind that each power system is an individual case with regard to power-factor improvement, and for that reason no definite rules for its solution can be given. However, a number of general principles can be set up which may be used as a guide. A paramount question in any power-factor study is: Is the improvement justified economically? The benefits, such as lower investment in plant equipment, improved service and operating conditions derived from power-factor improvement, must be weighed against the cost of the equipment necessary to improve the power factor. The disadvantages of low lagging power factors are:

1. The investment in electrical equipment increases as the power factor decreases.

2. The losses in the electrical equipment vary inversely as the square of the power factor, thus materially increasing the operating costs.

3. The voltage drop increases as the power factor decreases.

When the voltage drop is more than 10 per cent the slip of induction motors becomes abnormally large, their efficiency is impaired and their windings overheated. The latter may greatly increase maintenance costs.

With the limited amount of data available concerning O. R.'s power system, it is my opinion that installing capacitors would prove to be the most economical for improving the power factor. This conclusion is based upon the following considerations:

Installing a capacitor does not necessitate the replacement and consequent retirement or scrapping of probably good induction motors, which might prove too expensive. The capacitors do not necessitate changes in foundations. Their installation costs are comparatively small and they require no attendants and have negligible losses. Capacitors are built such that units, to take care of increasing load, may be added at any time. Power-factor improvement is obtained with the least possible disturbance to the existing operating conditions.

West New York, N. J. KERMIT B. HOFFMAN.

Control for Feed-Water Temperature

THIS IS A REPLY to the criticism by W. S. Hobbs (*Power*, March 1) of my article published in the Jan. 19 issue.

In theory Mr. Hobbs' reasoning is correct, but in actual practice some individual cases similar to the one I mentioned will differ. In the actual operation of this arrangement let it be assumed that the temperature of the steam to the heater is at its peak and the by-pass has partly opened. In this case the heater will have less water passing through the tubes and proportionately less condensation of the heating steam. As a result the trap on the condensate discharge will automatically control the steam passing through and reduce it.

The steam line to this heater is much larger in diameter and is at much higher temperature than the feed-water line so the cost of a regulating valve here would be enough more than that of the water used to pay for the additional fittings that would be eliminated in Mr. Hobbs' plan. HARRY M. SPRING

West Roxbury, Mass.

ON PAGE 339 of the March 1 number of *Power*, there is a criticism by W. S. Hobbs, of a scheme put forward by H. M. Spring for controlling the temperature of the feed water from a closed heater by automatically bleeding cold water into the pump suction. Mr. Hobbs claimed that it would be preferable to automatically control the supply of steam to the heater.

The fact appears to be lost sight of that the automatic steam control valve would be many times larger than the water control valve, as originally suggested, and would, therefore, be considerably more costly. Taking an average installation, one would expect, with an 8-in. exhaust connection, say, a 4-in. pump suction, which would only require about an $1\frac{1}{4}$-in. cold-water valve to maintain the temperature within reasonable limits.

Would it not be more desirable, however, to locate the heater on the discharge side of the feed pump, and thus do away with all trouble due to the pump becoming steam bound? D. F. GRAHAME.

Montreal, Que.

READERS' PROBLEMS

COMPOSITION OF BRASS ALLOYS—*What is the composition of the following metals: ordinary brass, tobin bronze, phosphor bronze, acid-resisting bronze? Will sulphuric acid eat zinc?* F. H.

Ordinary, or commercial, brass may be divided into two classes: cast brass and wrought brass. Cast brass contains 30 to 40 per cent zinc; the most common variety contains 35 per cent zinc and 65 per cent copper. Wrought brass comes in a number of classes, in which the copper ranges from 95 to 60 per cent; the remainder is zinc with a slight amount of tin and lead.

Tobin bronze contains 58 to 60 per cent copper and 39 to 40 per cent zinc, the remainder being iron, lead and tin.

Phosphor bronze consists of 91 to 97 per cent copper and 3 to 9 per cent tin, with a trace of phosphorus.

There are a number of so-called acid-resisting bronzes. One of these, "Everdur," is a copper-silicon-manganese alloy, which, besides the copper, contains 3 per cent silicon and 1 per cent manganese. Another alloy that is highly resistant to acid fumes is Monel metal, which is a natural alloy of 70 per cent nickel, 1½ per cent iron and 28½ per cent copper.

Ordinarily, bronze has no zinc, its place being taken by tin. In copper-zinc alloys sulphuric acid will atack the zinc and copper. Zinc alone is rapidly eaten by the acid.

RELATIVE MERITS OF PRESSURE AND VACUUM HEATING—*During a friendly argument on steam heating between a friend and the writer, we decided that an answer from you would settle the argument. Will you kindly advise us if there is a saving in steam consumption between the two methods enumerated below of operating a heating plant, and, if so, how is it figured out?*

First, the heating plant operates on a constant pressure of 8 lb. in the steam lines, the vacuum pump operating merely as a boiler-feed pump; second, the steam line pressure is reduced to 1 lb. or below and the vacuum pump permits pulling a normal vacuum of 7 inches.

C. E. N.

On the assumption that in each case the system heats the same building to the same temperature, say, 70 deg. F., the amount of coal needed will be the same. In each case the building will require the same amount of heat in the steam. Since the condensate is returned to the boiler, the only heat lost is that employed to heat the building.

It is assumed, of course, that both systems have equally effective controls. If this assumption is wrong then the system with the best control will show a saving in coal.

EFFECT OF SUCTION PRESSURE ON AMMONIA COMPRESSOR POWER—*I find on page 32 of Power's Practical Refrigeration the statement that the load on the compressor decreases with the suction pressure, which, in turn, tends to increase the steam consumption per horsepower developed, if the compressor is steam-driven.*

I believe that the load on a compressor increases as the suction pressure decreases and that the load decreases as the suction pressure increases.

E.B.B.

The horsepower required per ton of refrigeration increases with a decrease in suction pressure, but with any given compressor the horsepower input decreases with a decrease in suction pressure. These two statements are not in opposition, for with a decrease in suction pressure the tonnage capacity of the compressor decreases.

The work done in the compressor may be found by the formula:

$$Work = 144 \frac{n}{n-1} P_1 V_1 \left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} \right]$$

When $n = 1.3$ for ammonia.

P_1 = Suction pressure per sq.in.
V_1 = Suction volume, cu.ft.
P_2 = Discharge pressure, lb. per sq.in.

Examination of the bracketed expression shows that with the discharge pressure P_2 constant, the value of $\left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} \right]$ increases when the suction pressure P_1 decreases but the portion outside the bracket decreases as P_1 decreases, and within the range of ordinary suction pressures the latter over compensates for the former increase.

For example, let the discharge pressure be 150 lb. abs. with a suction pressure of zero gage, or 15 lb. abs., the work done per unit cubic feet of piston displacement will be

$$Work = 144 \times 4.33 \times 15 \times \left[1 - \left(\frac{150}{15} \right)^{0.23} \right], \text{ or}$$

$$Work = 9{,}353 \times -0.7 = -6547 \text{ ft. lb.}$$

The negative sign merely indicates that work is being done on the ammonia in place of the ammonia doing work.

The values of the work in foot-pounds to compress one cubic foot of gas at various suction pressures to 150 lb. discharge pressure are:

Suction Pressure, Lb. per Sq.In. Abs.	Work, Foot-Pounds
15	6,547
30	8,417
45	8,978
50	8,884
60	8,791
75	7,949

It will be noticed that at about 50 lb. abs. further increase in suction pressure causes the work to decrease. It should be understood that this discussion is based on a compressor without clearance and with 100 per cent volumetric efficiency. Due to reexpansion of clearance gas the amount of work is less than calculated, but the decrease is greatest at the lowest suction pressure.

▼ ▼ ▼

Readers Skeptical About Cooling Proposal

Summary of Readers' Opinions on the Previous Question

IS THERE any reason why I cannot pump well water, and circulate it through radiators to cool our building in summer? With 60-deg. water, how much heat will each radiator remove per square foot, assuming the room air is cooled from 80 to 72 deg. F.? C.C.M.

Plan Is Impracticable

ASSUMING that the radiators of the heating system are placed at floor level, cooling a building by circulation of cold water through the system would be wholly ineffective. The basic reasons for this are the retarded air circulation due to the position of the radiator, and the inadequacy of the radiator surface to absorb all the heat entering the room through the walls and windows.

The low temperatures involved reduce radiation to a minimum, and the heat-insulating property of air makes conduction unappreciable. Practically all the heat, therefore, will have to be brought to the radiator by convection. As convection is caused by circulation and as the circulation in this case is impaired, very little of the heat in the room will reach the radiator.

Under the conditions given, the difference between water and room temperatures is 12 deg. For this range the radiator coefficient of heat transmission is approximately 1.5 B.t.u. per square foot per degree temperature difference per hour. With the same freedom of

circulation as obtains with steam radiation, each square foot of radiator surface would absorb about 18 B.t.u. per hour. Slow circulation due to position of the radiator reduces this to about 9 B.t.u. The cold zone thus obtained would not rise, for all practical purposes, above the radiators without artificial circulation.

Even with artificial circulation the desired cooling could not be obtained. Heating systems in this locality are designed for a 70-deg. difference between inside and outside temperatures. In our problem, the temperature difference is 8 deg. With the same number of air changes in summer as in winter, the radiators would have to absorb 8/70 of the heat they emit in winter. But as the number of air changes in summer is actually much greater, this ratio is more likely to be about 16/70. Each square foot of radiation would have to absorb, therefore, $16/70 \times 240 = 55$ B.t.u. per hour. Since the rate is 9 B.t.u., or at best 18 B.t.u., the inadequacy is evident.

There would be additional drawbacks. The humidity of the cooled air would be increased, and if the original room humidity be above 50 per cent the water vapor in the air would condense on the radiator. Among the operating disadvantages can be listed the changes in the system necessary to prevent short circuiting of cold water through drips and traps on supply lines, and to prevent possible injury to indicating and controlling equipment designed for heating pressures and exposed to the much higher pressures occurring with water circulation. There is also the possibility of scaling and corrosion of system because of dissolved salts in water.

New York City B. L. SPIVAK.

System Will Sweat

PROBABLY the most serious objection to the use of a radiator system for cooling a building in the summer time is that condensate accumulates on the outside of radiators and pipes. If water at 60 deg. F. is circulated through the system, condensation will occur whenever the dew point of the surrounding air is 60 deg. F. or above. Since the dew point of atmospheric air is usually above this point during hot weather, trouble from this source may be expected continuously.

Aside from the objectionable dripping of water from radiators and exposed piping, the pipe insulation will probably be subjected to deterioration from the condensation which will form next to the pipe, unless a moisture-tight seal has been provided on the outside of the insulation. A moisture-tight seal, however, is not usually provided around the insulation of hot pipe lines. If on the other hand, the piping inside the walls is bare, condensation at this point is sure to cause rapid rotting of the woodwork.

Another difficulty in using the radiator system for cooling would be the lack of sufficient cooling surface. The heating system was probably designed for a considerable temperature difference between the steam in the radiators and the air in the rooms. With 60-deg. water and an average room temperature of 75 deg., the difference of 15 deg. is probably about one-tenth of the temperature difference existing when the system is used for heating. In this case the heat removed by the radiators as cooling media would be somewhat less than one-tenth of their capacity for adding heat to the rooms in the winter time.

A heat-transfer rate of 1.5 B.t.u. per hour per square foot per degree F. temperature difference is about all that could be expected for the system unless some mechanical means were provided for increasing the circulation of the air through the radiators. With 60-deg. water and an average air temperature of 75 deg. the heat removed per square foot of radiator surface would be about 22.5 B.t.u. per hour. J. I. HUDSON.

Nashville, Tenn.

A Cold Shower For the Building

ASSUMING the "radiators" to mean cast-iron direct radiation, I do not see how any successful cooling can be accomplished by pumping 60-deg. water through it. The natural air movement over the cooling surfaces would be too weak to rise high enough to mix with the heated air at the breathing plane and if the water is cooled further it may be at a temperature below the dew-point of the air, resulting in condensation collecting on the cooling surfaces. The sluggish air movement and the possibility of condensation dripping from the cooling surfaces and supply piping would do much to defeat the project. With convectors and a vigorous forced air movement over the cooling surfaces, and window-sweeping air grills, some possibilities remain, but as the question does not state that this form of radiation is used it is difficult to say just what can be done.

The cooling energy, for acceptable cooling, must be sufficient to condense air moisture, absorb heat gains from occupants, lights, motors, and the heat transmitted by sunshine on the walls, roof and windows and the air leakage and infiltration.

Most room occupants resent closed windows in summer and will open windows regardless of the cooling device in the room. This air leakage amounts to considerable and if this air can be dehumidified to some extent some cooling is possible, even with the open windows.

If C.C.M. will spray his 60-deg. water into a tank in which a high vacuum is maintained he will cool his water to about 45 deg. This water may then be pumped through a well-insulated pipe to one or more perforated spray pipes running around the building's outside walls. These sprays will trickle downward and wet the walls with this cold water and dehumidify the outside air to some extent before it enters the building. WILLIAM ANDERSON.

Brooklyn, N. Y.

Note to Readers

AT PRESENT a period of five weeks intervenes between publication of a question for readers and that of the selected answers. To cut this period to four weeks, for the sake of reader interest and convenience, the question is omitted this time, but will appear as usual next week.

More Radiation Needed

THE PROBLEM is not to "cool the room air from 80 deg. F. to 72 deg. F.," but to maintain a temperature of 72 deg. in the room when the outside temperature is higher, in this case evidently 80 degrees. In other words, it is not a question of cooling a certain number of cubic feet of air contained in the room to a lower temperature, but to remove from the room as many heat units as are transmitted through the walls, windows, etc., from outside.

At the extreme outside temperature for which the heating installation (especially the radiating surface) was designed, say at 10 deg. F. outside temperature, the difference between outside and inside temperature will be about 62 deg. The number of heat units to be supplied or removed by the radiators will be proportional to this temperature differential. The heat units transferred will also be proportional to the temperature differential between the steam in the radiators (220 deg.) and the room air (72 deg.). That is, for every degree of difference between inside and outside air there will be $148 \div 62 = 2.43$ deg. difference between steam and room air.

If cold water is used the differential between inside and outside temperatures will be $80 - 72 = 8$ deg., and that between the room air and cooling water $72 - 60 = 12$ deg., assuming that a limitless amount of cooling water will be pumped through the radiator so that its temperature will not increase. In this case, for every degree of difference between inside and outside air there will be $12 \div 8 = 1.5$ deg. difference between cooling water and room air. Due to this small difference the radiators will be less effective. Other conditions being equal, the radiators should be $2.43 \div 1.5 = 1.62$ times as large to be in the right proportion.

In addition, the heat transfer coefficient from air to water will be less than from steam to air and some rise in water temperature must be allowed for.

ANDREW A. BATO.

East Orange, N. J.

Air Conditioning Discussed at Cleveland Conference

Better definition of terms needed; reversed refrigeration cycle adaptable to both summer and winter conditioning; closer study of air pollution necessary; effect of air conditioning on electric bill discussed

TWO fundamental problems came into bold relief at the conference on air conditioning held March 17 to 19 at Cleveland under the joint auspices of the Case School of Applied Science and the Cleveland Engineering Society. The attendance was between 400 and 500.

The first of these problems had to do with a definition of terms. Several of the papers and informal discussions emphasized the fact that unless very soon the industry makes plain to the public just what constitutes aid conditioning and what constitutes room heating or room cooling, there would be innumerable fly-by-night manufacturers rading on the popularity of a new trend. The other problem was one which concerned the engineering phases of air conditioning. Here, too, several of the speakers pointed out the danger of complicating air conditioning with too many mathematical formulas—making it appear to be so exact a science that what equipment manufacturers might be able to supply, which would meet the engineers' specifications, would be too costly for popular use.

The conference was called because of a belief that greater knowledge was required concerning the newer applications of air conditioning; that is, commercial and domestic uses. It was taken for granted, more or less, that industrial air conditioning did not require quite the intensive investigation as the newer applications.

Avoidance of Technical Complexities

F. Paul Anderson, dean of engineering, University of Kentucky, was the principal champion for simplification of domestic air conditioning. Don't become involved in technical complexities, was his advice. With a working knowledge of a psychometric chart, and a familiarity with the uses of a psychrometer, he said that human comfort could be immeasurably increased. "Know how to develop effective temperature," he said, and more than half the air-conditioning objectives would be secured.

Though many papers related to commercial and domestic air conditioning, several presented data fundamental to he industrial applications as well. Some of the more important facts brought out in the various papers are listed in the following paragraphs.

In speaking of the air conditioning of railway cars, W. H. Carrier, Carrier Engineering Company, asserted that, because of its ability to take advantage of existing power, always present, the steam-ejector system of refrigeration, as opposed to motor-driven units, would probably prove to be the most popular. Ice, perhaps, was the most practical refrigerant for short runs, such as from Philadelphia to New York, though the difficulty of icing for such large evaporation requirements was a real one. The unit system of car refrigeration would probably be the most popular, since central systems would not allow free switching of cars or flexible makeup of trains.

G. L. Larson, head of the department of mechanical engineering, University of Wisconsin, said that the leakage of air through building walls constitutes the largest heating loss. One office building study showed a leakage into the building of from 6 to 25 per cent, such a variation being largely dependent upon how securely the plaster was bonded to the baseboard. The leakage through windows without weather strips varies from 70 to 176 cu.ft. of air per hour, based on a 15-mile wind, the variation depending on the type of window used. Because of this infiltration, for two air changes an hour one gallon of water an hour should be added for conditioning (40 per cent relative humidity) each 10,000 cu.ft. of room space. Any conditioning system must take full account of wind force, density, furnace effect and fans.

R. E. Robillard, application engineer, Frigidaire Corporation, reported that in unit conditioning, from 10,000 to 12,000 B.t.u. per hour are all that are required for cooling and dehumidifying, and about 15,000 B.t.u. per hour for heating and humidifying for from 200 to 350 sq.ft. of floor space. The use of toxic gases is inexcusable. The public is so used to radiators that there is little chance now of departing from radiator design in making unit conditioning equipment. As soon as the novelty of unit conditioners has worn off the public will demand a minimum of noise. Operating costs will become lower as the efficiency of units is increased. There must be a minimum of distribution losses.

Application of Reversed Cycle

In discussing the reversed refrigeration cycle for summer and winter air conditioning R. E. Keyes, Chief Engineer, Cooling and Air Conditioning Corporation, New York City, came to the conclusion that the best possible use for heating should be made of the refrigerating system, primarily required for dehumidifying and cooling, and that the adaptability of the system for heating depends considerably upon the refrigerant used. Mr. Keyes asserted that very few carbon dioxide installations could be utilized in a compression heating system, because "the critical temperature is so low that the maximum temperature of water leaving the condensers would hardly be efficient as a heating medium."

Mr. Keyes found the possibilities offered by ammonia much better. Theoretically, the critical temperature and pressure are so high that either high temperature water, or even steam, can be produced. But, due to the fact that standard ammonia compressors are normally built to withstand maximum gage pressures of 300 lb., the equipment is limited to panel warming and the tempering of fresh air supply, a water temperature of 120 deg. F. off the condenser being the upper limit.

Although used less than either ammonia or carbon dioxide, methyl

chloride, in Mr. Keyes' opinion, is becoming more and more popular for certain types of work. "As a refrigerant," said Mr. Keyes, "it approaches ammonia in performance," and operates at lower pressures under normal conditions. It is also fairly inexpensive, and is less objectionable than ammonia "from the standpoint of its toxic, explosive and irritating qualities." Standard ammonia compressors can be used with little mechanical modification for pumping. Further, "a compressor designed for summer cooling in which methyl chloride is used as the refrigerant can be used without any change in operation except the raising of the discharge pressure for producing water at relatively high temperatures."

Samuel R. Lewis, Consulting Engineer, Chicago, after discussing at length school and public building air-conditioning problems, summarized his observations as follows:

1—A conventional school house heating and ventilating system is typical of any heating and ventilating system.
2—When designed for heating only, such a system is usually ill adapted to summer cooling.
3—No modern mechanical ventilating system should be designed without consideration to the probable use of the ducts for summer cooling.
4—If artificial cooling is to be installed, provision must be made for maintaining the temperature of the various rooms independently of the temperatures in the other rooms.

Not only is more and more being learned about the technology of air conditioning, including air currents, air infiltration, etc., but the subject of air pollution and how to correct it is being given greater attention. Dr. E. Vernon Hill, of Chicago, emphasized the fact that air conditioning was much more than heating and cooling, humidifying and dehumidifying. He asserted that it included knowledge of temperature, air motion, pressure, light effects, ultra-violet and infra-red rays, radiation, dust, bacteria, carbon dioxide, nitrogen and other elements. He described tests being conducted on nude subjects under varying temperatures to find out those air conditions which yielded the lowest metabolic rate. The ultimate objective of these tests would be the fixing of the temperature and humidity ranges most conducive to sleep, heavy work and light work. It was found that nude subjects finished the sorting test quicker at a temperature of 86 deg.; and that the subjects wearing the normal amount of clothing—about 12 ounces—preferred a temperature of 80 degrees.

F. C. Houghten, director of the American Society of Heating and Ventilating Engineers' research laboratory, asserted that "since air conditioning for human comfort is essentially to reduce desired physiological response of the occupant, it is important that the air conditioning engineer have some understanding of the physiological processes affected by thermodynamic conditions of the atmosphere, or its temperature, humidity and motion." Mr. Houghten explained the development of the psychometric chart, which other speakers asserted should be the foundation for all air conditioning computations and the starting point for equipment design so that the effective temperatures shown in the comfort zone could always be secured.

Air Pollution Requires Further Study

Another paper referring to the need for greater study of air pollution was presented by H. B. Meller, head of the air pollution investigation of the Mellon Institute of Industrial Research. Mr. Meller traced the smoke abatement activities engaged in by various cities and said that though there had been a progressive decrease in the amount of dense smoke from 1912 to 1930, sootfall surveys showed that the ratio of combustible soot to ash had remained practically unchanged. This meant, he said, that smokeless chimneys did not mean harmless ones. Analysis of the precipitated solids showed these results: 1912-1913, combustible, 42½ per cent, ash, 57.5; and 1930, combustible, 43.4 per cent, and ash, 56.6 per cent.

The way is open, the speaker declared, for a tremendous forward step in "the abatement of preventable air pollution by (1) automatic fuel feed and any other regulations that will make for more nearly complete combustion, and (2), separation of dust to the practical limit."

Howard C. Murphy, chairman of the A.S.H & V.E. Committee on Air Cleaning, reported some interesting studies conducted to show the relation between excessive pollution of air and the prevalence of respiratory diseases. He also exhibited graphs to show that, in the city of Akron, Ohio, absenteeism in public schools varied directly as dust concentration in the various school wards. Mr. Murphy reported that pollen counts in a number of Chicago buildings had disclosed the fact that, because of its conditioned air, Field Museum showed only half the pollen count of the air of several northern resorts popular as havens for hay-fever sufferers.

Electric Power Supply

Two papers relating to electric power supply used in air conditioning equipment were read. R. E. Hellmund, of Westinghouse Electric & Manufacturing Company, and J. H. Walker, of the Detroit Edison Company, both emphasized the possibility of the resident consumer getting better kilowatt-hour rates through increased load, as well as through ability to utilize "off-peak" power. Mr. Walker said that power production and operation costs had about reached the minimum and that the rate resident consumers paid in numerous instances barely paid fixed charges. In fact, he said, in some cases "it costs more to answer the customer's questions than it does to pay for the coal that produces his power."

Mr. Walker showed graphs of studies his company had made showing the possible increased loads through the use of air-conditioning equipment. He reported that the average resident consumer's power use was about 550 kw.-hr. yearly. An oil burner motor would consume about 250 kw.-hr.; an electric refrigerator, 540 kw.-hr.; an electric range, 1,500 kw.-hr.; a water heater of the sort which now uses off-peak power, 3,600 kw-hr. yearly. In a 44-story Detroit office building, the lowest 18 stories (including basement) of which are air conditioned, a carbon-dioxide system uses 600 tons of refrigerant daily to condition approximately 3,000,000 cu.ft. of space occupied by 1,850 people. The cost is $14,000 a year.

Friability of Coal To Be Studied by A.S.T.M.

A new subcommittee of the American Society for Testing Materials—Committee D-5 on Coal and Coke—has been organized to study methods for determining friability of coal. The meeting at which the subcommittee was formed was part of the A.S.T.M. annual spring group meetings of committees, held in Cleveland, March 7 to 11. This new subcommittee, under the chairmanship of R. E. Gilmore, Department of Mines, Canada, is made up of various investigators of the United States and Canada, who have given special attention to the determination of friability or strength of coal. This work is of special importance because various investigators report results based upon different methods of making this determination. The objective of the committee will be to develop a standard method for determining the tendency of a coal to degrade in size on handling.

An important progress report was presented to the main committee on the standardization of a test for determining the agglutinating or caking index of coal. This test promises to be of special usefulness in evaluating the caking properties of coal in connection with its use in various types of stokers, and quite probably will be of considerable value in the selection of blends of coal in the production of coke.

A suggestion was made that the shatter test for coke be modified to use a 100-lb. sample instead of a 50-lb. sample as now specified, and that the results of shatter tests be reported on the basis of not less than three tests. This proposal was referred to the appropriate subcommittee for investigation.

The subcommittee on coke sampling reported a tentative method for sampling coke for analysis, which was accepted by Committee D-5, and this will be referred to the committee for letter ballot.

Erosion of Steam Turbine Blades

By F. W. GARDNER

BLADE EROSION is a problem, frequently resulting from unexpected causes, which has recently been brought into great prominence by advances in peripheral turbine speeds. It is not a new problem, but its importance was not appreciated until a stage was reached at which erosion occurred so rapidly in service as to suggest that it might prove to be a limiting factor, retarding progress in design.

In its widest sense, the erosion refers to a wasting away of the material of a structure under the continued action of fluids flowing past or against it. In a great many cases the wastage is due entirely to a chemical action, and when this is so the term corrosion should be employed. Still more frequently it is due to a combined chemical and mechanical action.

Confusion frequently results from a failure to discriminate between corrosion and erosion effects, and it is important that the distinction should be clearly understood. True erosion, as defined above, can only be produced when the stresses set up by the impact of the fluid are of such magnitude as to cause rupture of the surface layer of the material. Such stresses must, therefore, be of high order of intensity, but are usually extremely local in their action, and the disintegration that results is the cumulative effect of repeated application.

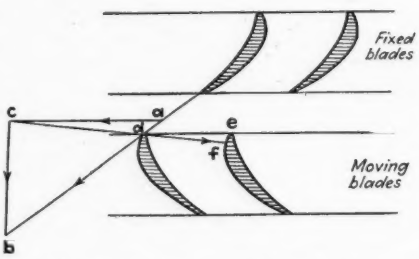
Erosion Caused by Low Water Velocity

In that portion of a steam turbine where the expansion is below the saturation line, water separates out from the steam during its passage through the blades or nozzles. The water collects into droplets on suitable nuclei, and the droplets accumulate on the surface of the blades to form drops of varying size. The water drops formed in this way on a stationary blade are not accelerated with the steam. The velocity they can attain from the combined effect of the pressure drop and the drag of the steam jet is small, and they are, therefore, thrown off from the exit edge of the blade with a comparatively low velocity. Some of them pass on until they are struck by the blade of the succeeding moving row, the velocity of impact approximating the rotational velocity of the blade. If the velocity is high the force of the impact may be great enough to cause a local deformation of the metal, and as the leading edge of the blade is exposed to a constant repetition of such blows the surface gradually disintegrates. In process of time, as the action continues, the metal may be worn away to a considerable depth.

[1]Abstract from *The Engineer*, London, Feb. 5, 1932.

Erosion of a turbine blade is due to the high velocity of the blade, and not to velocity of the water. The reason for this will be clear from the diagram in which a typical example of the last stage blading of a reaction turbine is shown and in which velocity triangles for the relative motion of steam, water and blades have been drawn.

The steam issue from a fixed blade with a velocity represented by *ab*. This, compounded with *ac*, which represents the circumferential velocity of the blade, gives a relative velocity *cb*, the direction of which is more or less axial, and the inlet angle of the moving blade is arranged to suit this direction, so that the steam may enter without shock. Water, as it reaches the exit edge of



Turbine blade diagram showing relative velocities of water particles

the fixed blade, is brushed off by the steam stream, from which it derives a small velocity that may be represented in the plane of the diagram by the line *ad*. In addition, it may or may not have a radial velocity. The resultant of *ad* and *ac* is *cd*, which, therefore, represents the relative or impact velocity of the water and the blade. It will be seen that it is nearly equal to the blade velocity, and is inclined to its direction at a small angle, usually of the order of 5 deg. If *de* is the blade pitch, and *cd* is produced to strike the profile of the adjacent blade at *f*, then *ef* is the only portion of the blade surface which is exposed to bombardment. Erosion is found, therefore, to occur on the convex side of the blade, and is initially confined to a comparatively small area of the inlet edge.

The velocity of the water will depend on the precise point in the passage to the blade at which it separates out. That which results from condensation near the outlet of the fixed blade, where the steam has already attained considerable velocity, will continue to move with the steam in the form of fine mist, and will have a velocity comparable to that of the steam. It will, therefore, enter the moving blade almost without shock. Drops formed near the inlet of the fixed blade, however, will flow along the blade surface to the exit edge, where they hesitate momentarily, as they come under the influence of the slight eddy which always exists there, before they are carried on by the steam. Although acceleration in rapid, the velocity they attain by the time they reach the rotor blades is small, compared to that of the steam itself. The magnitude of this velocity can be inferred from an examination of affected blade, that is, by measuring the width *ef* and drawing the diagram in the reverse order.

In a pure impulse turbine the diagram, would be modified because the velocity of the steam jet leaving the nozzle will be greater than *ab*. The effect of this will be to increase the water velocity *ab* and reduce the impact velocity *cd*, but as the whole of the expansion takes place in the nozzle, the amount of condensation will be greater. Actually, the modern high-speed impulse turbine employs a considerable amount of reaction in its last stage, and its diagram is not greatly different from that shown.

Localized Erosion Frequently Occurs

Turbine blade erosion frequently occurs in several localized places along the entrance edge. This localized effect is believed to be due to such factors as binding strips in preceding blade rows, and to irregularities in cylinder design.

Erosion action is most rapid when the machine first goes into service, and as the indentation proceeds its progress becomes steadily slower. Thus the blades may show after twelve months' service less than twice the depth of indent that appear at the end of the first month.

By applying theoretical mechanics of the closely related problem of the collision of elastic solids and making certain other assumptions, it is possible to form conclusions as to the actual magnitude of the pressures produced by the fluid impact with the turbine blading. These considerations show that the pressure is proportional to the first power of the velocity, and that it does not depend on the size of the drop. As regards the actual magnitude of the forces, it leads to the conclusion that the pressure resulting from direct impact at 1,000 ft. per second velocity will be of the order of 40 tons per square inch.

▼

"Under the urge of increasingly severe conditions of operation the best boiler-making practice is now definitely taking its place among the more exact of the engineering arts. Failures resulting entirely from injudicious treatment in the shop are probably less common than they used to be, but severe working conditions on the other hand are accounting for more than formerly. Fortunately we have at our disposal nowadays means of tracing their origin."—From report of V. B. Harley-Mason, chief engineer of Manchester Steam Users Association.

WHAT'S NEW IN PLANT EQUIPMENT

New Low-Head Boiler

THE Lasker Boiler & Engineering Corporation, 3201 South Lincoln St., Chicago, Ill., is announcing two new models of the Burton boiler.

Due to their distinctive design, these boilers may be installed with extremely low headroom. For this reason, the boilers are particularly adaptable for installation in the heatig plants of buildings where high rental values place a premium on space occupied.

Both are of the bent-tube type, one a two-drum and the other a three-drum boiler. The two-drum type is used particularly for direct-fired steam or hot-water heating, but can also be used with equal facility as a steam producer. Reduction of the drums to two, in this boiler, results in a lowered cost due to the saving possible by eliminating the third drum, together with the shop costs of drilling this extra drum for tubes and connections.

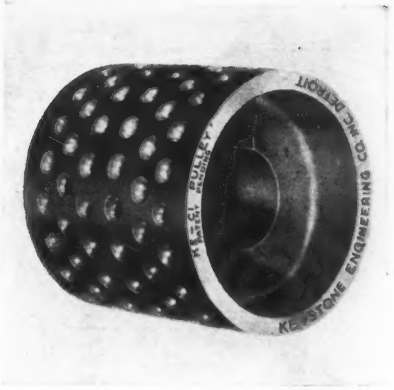
The three-drum type, built in units from 200 to 600 hp. and for pressures up to 600 lb., offers an efficient and rapid steaming unit for industrial plant installation. This boiler may be fired from either end without any change in baffling. Steam is liberataed in the upper drum of the boiler and passes to the outlet connection through a dry pipe to prevent the carryover of moisture.

Both boiler types are adaptable to the usual methods of firing, and setting heights may be varied to suit the requirements of the fuel used.

Vacuum Cup Pulley

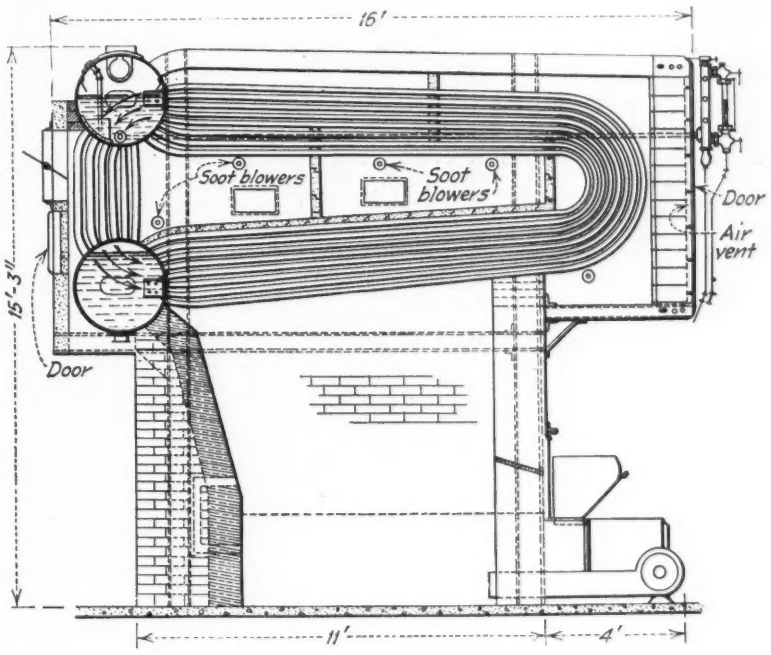
A NEW PULLEY, designed to prevent belt slippage, has been made available by the Keystone Engineering Company, Inc., 850 Maccabees Building, Detroit, Mich.

On the face of the pulley have been formed cups, in which it is claimed that a vacuum is formed by the belt as it approaches the pulley. The vacuum in each cup acts as a seal, and holds the belt in place as it rides over the pulley.

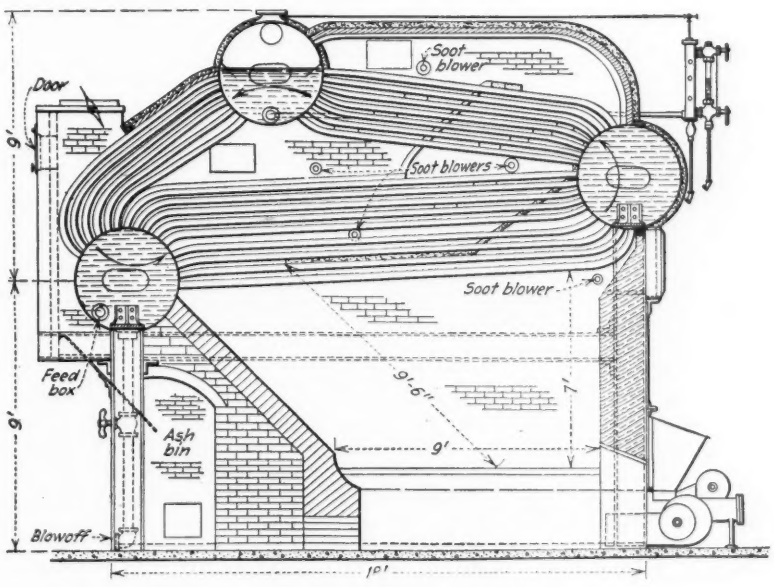


New Keystone vacuum-cup pulley

The regular sizes of vacuum cup metal pullies offered vary from 3 to 16 in. in diameter, and face widths from 2 to 14 inches.



Two-drum Burton design



Three-drum Burton design

New Bronze Welding Rod

A NEW bronze welding rod, known as "Oxweld No. 25 M. Bronze Patented Welding Rod," has just been introduced by the Linde Air Products Company, 30 East 42d St., New York, N. Y. Because of its special characteristics, this improved manganese bronze rod is particularly adapted to use in the rebuilding of wear-resisting surfaces such as piston rings or cylinder walls. It is said to be non-fuming and exceptionally free-flowing and to show a Brinell hardness of 96 in the weld.

It is easy to remelt and reweld welds made with this rod and to build up large welds in layers, because, it is claimed, no heavy slag forms.

The new welding rod is supplied in three sizes: $\frac{1}{8}$ in., $\frac{3}{16}$ in., and $\frac{1}{4}$ in.

NEWS of the FIELD

Leaking Turbine Oil Ignited by High-Temp. Steam Causes Fire in New Harding St. Station

SHORTLY after midnight on March 15 an oil leak developed in the high-pressure oil system of one of the 35,000-kw. turbine units recently placed in service at the Harding Street station of the Indianapolis Power & Light Company. The leaking oil ignited when coming in contact with the high-temperature steam chest piping. The operator on duty attempted to stop the leak while the machine was in service, but failing to do so, the unit was taken off the line and shut down.

With full field on the generator the unit came to rest in approximately twenty minutes, but during this period the auxiliary oil pump had to be kept in service to supply lubricating oil to the turbine bearings and a considerable amount of oil was thus spilt over the magnesia covering of the steam chest and around the turbine. This kept on burning for some time after the machine had come to rest and a considerable fire developed.

Fire apparatus from three fire houses of the City of Indianapolis responded to the alarm and fought the blaze until after three o'clock in the morning.

Some damage to the valve-operating relays and other steam chest parts was caused around the turbine itself. In addition, the tile walls and floors of the plant were covered with about $\frac{1}{8}$ in. of oil soot and other minor damage in the vicinity of the fire was done.

The steam chest around which the fire developed and centered, is located remote from the turbine proper and because of this, damage to the turbine-generator was little.

The machine on which the fire started was the only one operating in the plant at the time (12:30 a.m.). Because of the heat and intensity of the fire, the plant was taken off the line and the load transferred to the two older plants of the city, part being picked up by the inter-connection with the Public Service Company of Indiana's Dresser station at Terre Haute.

While the other unit in the Harding Street station was available for service as soon as the fire was extinguished, it was not put back into service until some time Wednesday, the 16th. Late Tuesday forenoon, (the 15th), the unit on which the fire had occurred was so hot that company employees could not touch it. No major damage was done, however, to this turbine-generator unit, and after minor repairs have been made around the steam chest and valves it will again be available for service.

An interesting feature of this fire is that the leaking oil was ignited by the temperature of the steam-chest parts with which it came in contact and which contained steam at a temperature over 700 deg. F.

Hearing Ordered on Delay Of White River Project

A PUBLIC HEARING on the postponement of a license to the Empire District Electric Power Company to construct a $16,000,000 hydro-electric power project on the White River at Table Rock, Mo., has been ordered by the Federal Power Commission for May 3, George Otis Smith, chairman of the commission, announced March 22.

The company is seeking a delay in the issuance of the license for one year. Its petition to the commission sets forth in substance that due to present economic conditions there is no "present or probable early need or market for the power which would be generated by such project," and also that the financing of such project, estimated at $16,000,000, would be "unreasonably expensive now, if not impossible."

At the hearing on May 3, the commission will consider the questions of whether it has the authority to grant the request of the company and if so, whether it should, under all the circumstances, allow the postponement.

S.C. House Passes Bill to Extend Utility Regulation

A BILL to extend the State Railroad Commission's control over electric utilities has just been passed by the South Carolina House of Representatives. Introduced by the Committee on Judiciary, the bill was originally written by the Power Rate Investigating Committee, created by the 1931 Legislature, which submitted to the present session an exhaustive report of the electric power situation in the State.

The measure provides that whenever there is a "reasonably substantial affiliation" of an electric utility in the State who is in a position to exercise "any reasonably substantial control," the burden of proof shall be on the utility to establish the fairness of management, construction or other fees, and unless shown to be reasonable they shall not be allowed in a rate case.

Efficiency on the part of an electric utility, however, is to be rewarded, according to the bill, which provides:

"For the purpose of encouraging economy, efficiency and improvements in methods or service any electrical utility may participate, subject to the approval of the commission, to such extent as may be permitted by the commission in the additional profits arising from any economy, efficiency or improvement in methods or service instituted by such electrical utility."

The bill provides that municipalities shall be included in the regulatory provisions "to the extent of their business, property, rates, transactions and operations without the corporate limits of the municipality."

The measure also would confer upon the commission power to control the issuance of securities, and to control or limit the depreciation reserve which the utilities would be required to maintain.

Two Die as Pulverized Coal Buries them in Brooklyn

TWO LABORERS employed by the Brooklyn Union Gas Company were killed March 22 when they feel into a 60-ft. steel bin, containing twenty tons of pulverized coal. Like quicksand, the coal rapidly closed over their heads and suffocated them.

The men, Lawrence Sissin and Elisio Fernandez, were working in the company's plant at Maspeth and Varick Avenues, Brooklyn, N. Y. Wearing safety belts, they had lowered themselves into the coal container on a scaffold and had a safety rope to seize if the scaffolding gave way. Their job was to scrape the accumulation of caked coal from the sides of the bin.

Shortly after the two had started work, other laborers heard a rush of coal in the container and saw a dense cloud of black dust rise. They hastened to the spot and began digging, while an

emergency crew of the gas company was called. It took about half an hour to dig Sissin and Fernandez out. The exact cause of the accident had not been determined at the time of going to press.

Hell Gate Station to Have Three New Stokers

THE United Electric Light & Power Company of New York has just ordered three large Taylor stokers from the American Engineering Company, Philadelphia, for installation in the Hell Gate power station, New York City. Work is to start on April 1 and be completed by Sept. 1.

Roosevelt Vetoes Bill to Change State Steam Work

GOVERNOR ROOSEVELT of New York vetoed on March 23 the Slater bill amending the State finance law in relation to separate specifications for contract work for the State, by including steam power work in the heating group. In vetoing the bill the Governor said:

"The purpose of this bill is good but the language is so indefinite that the Superintendent of Public Works has written me as follows:

"'The words, *steam power work* in line 9, page 2, are too indefinite. They might be interpreted to mean an entire power house. The engine and generator are now let under the contract for electrical work. As they are an integral unit they should be in one contract. This law might put them in separate contracts. There would be all sorts of confusion as to just what "steam power work" meant.'"

St. Lawrence Treaty Soon Despite Quebec Opposition

QUEBEC QUESTIONS in connection with the St. Lawrence deep waterway scheme were under review at a recent conference in Ottawa between the Federal Government and representatives of the Quebec Government. It is understood that Premier Taschereau of Quebec held firmly to his previous position in opposing the St. Lawrence waterway and that he expressed the fear that if 1,000,000 hp. be developed by New York State, on the United States side, and if another 1,000,000 hp. be developed by the province of Ontario, on the Canadian side, the resultant advantage to industrial activity in Ontario and in New York would be seriously injurious to these interests in Quebec.

The conference followed similar meetings which the Federal Government had had recently with representatives of Ontario and members of the Ontario Hydro Electric Power Commission.

Premier Bennett's statement in the House of Commons a few days ago in answer to a question by W. L. Mackenzie King, opposition leader, would indicate that a treaty for the St. Lawrence development will be signed with the United States within the next few weeks, with the stipulation, however, that the treaty need not be submitted to the Canadian Parliament until ratified by the United States Congress, since on more than one occasion in recent years Parliament has ratified treaties on various subjects only to have Congress throw them out.

TRANSFORMER STANDS LIGHTNING TEST

Artificial lightning flashes of 1,500,000 volts proved harmless to this de-ion-equipped distribution transformer in a demonstration test conducted recently at the Westinghouse high-voltage laboratory in Sharon, Pa. The transformer was subjected to 175 lightning strokes, and at the completion of the test it was undamaged and unmarked. When lightning strikes this transformer, it jumps an ingeniuously devised gap, bi-passing the working parts and preventing disruption of service

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A.S.A. Issues Standard for 800-Lb. Cast-Iron Pipe Flanges

THE American Standards Association announces the publication by the American Society of Mechanical Engineers of the "American Standard for Cast-Iron Pipe Flanges and Flanged Fittings" for maximum non-shock working hydraulic pressure of 800 lb. per sq.in. (gage) at ordinary air temperatures. The standard was prepared by the committee on pipe flanges and fittings under the sponsorship of the A.S.M.E., the Heating and Piping Contractors National Association, and the Manufacturers Standardization Society of the Valve and Fittings Industry. The standard can be purchased at 35 cents per copy from the office of the American Standards Association, 29 West 39th Street, New York.

International Hydro Adds 130,000 Hp. to System

INTERNATIONAL Hydro-Electric System announced March 21 that it had purchased the bulk of the waterpower properties in the United States owned or controlled by International Paper Company, including the important powers on the Hudson River. The properties involved have a total potential capacity of 450,000 hp. of which 130,000 hp. is developed, over half in hydro-electric plants and the balance in hydraulic plants. This acquisition increases the installed hydro-electric generating capacity of the system to 1,248,000 hp., and raises it to the position of the world's third largest owner of hydro-electrically developed powers.

The Hudson River powers, concentrated in five sites above Albany, are the most important of the entire group. The balance of the powers are located on the Saranac, Black, Ticonderoga, Grass, Chateaugay and Raquette rivers in New York, on the Winnepesaukee River in New Hampshire, and on the Androscoggin, Penobscot and Kennebec rivers in Maine.

The transfer of the properties brings near to completion the paper company's program for segregating its power and utility operations from its pulp and paper operations. The building up of this affiliated group of integrated power and utility companies facilitates the efficient and economical development and financing of the group's extensive undeveloped power resources.

R. L. Robinson, of B. & W., Killed in Airplane Crash

RALPH L. ROBINSON, sales executive of the Babcock & Wilcox Company, New York City, was killed March 19 along with six other passengers in an airplane accident near Calimesa, twenty miles southeast of San Bernardino, Calif. Flying in a fog, the plane, which was en route from Phoenix, Ariz., to Glendale, a suburb of Los Angeles, struck a high-tension transmission line and crashed in an orchard when the pilot failed in a five-minute attempt to recover equilibrium.

A native of California, Mr. Robinson

was born in June, 1890. He graduated from Leland Stanford University in 1912 with the degree of electrical engineer. Soon after he entered the employ of the General Electric Company and a year later was appointed to the New York Public Service Commission. In 1916 he became associated with the Griscom-Russell Company and on Dec. 1, 1930, joined the Babcock & Wilcox Company to take charge of sales of special process equipment, the position he held at the time of his death.

Mr. Robinson was a member of the American Society of Mechanical Engineers, National Electric Light Association, American Society of Naval Engineers and American Society of Steel Treaters.

Virginia House Passes New Water Power Bill

A BILL broadening the scope of the state corporation commission's control over water-power developments in Virginia, and which has a bearing on the contemplated developments at Goshen Pass and Radford, has passed the Virginia House by a vote of 79 to 5. A similar bill is on the Senate calendar on its third reading.

Advocates of the measure said it was favored by the corporation commission and the state conservation and development commission, and that it was not opposed by the power interests.

Under the measure, the corporation commission is given control over the construction of dams across any river or stream in Virginia, whether navigable or non-navigable, for the generation of hydro-electric energy.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Headquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Petroleum Division meeting in Room 502, Engineering Societies Building, Apr. 8 at 8 p.m. Subject: "Physical and Thermal Properties of Hydrocarbon Mixtures at High Temperatures and Pressures," W. K. Lewis.

A.S.M.E., Providence Section. Meeting in the Society Rooms, Apr. 5 at 8 p.m. Subject: "Engineering Responsibilities in the Pure Air Problem," Ely C. Hutchinson.

N.A.P.E., Philadelphia Locals. All-day meeting in conjunction with other engineering organizations, to be known as "Power Engineers' Day," at the Penn Athletic Club, Apr. 2. Technical sessions and entertainment.

New Small Steam-Storage Delivery Truck to Be Tested

BYRD CARDOZA, formerly identified with the electric traction and storage-battery truck fields, announces the formation of a new company, the Heat Battery Motors Corporation, to develop and manufacture a small delivery truck running on stored steam. It is expected that 100 of these vehicles will soon be tested on short bread and milk delivery routes in this country and Canada.

The truck will be powered by a multi-cylinder simple-compound steam engine fed from a steam accumulator. It will have a driving range of from 30 to 40 miles on a single charge of steam, Mr. Cardoza stated, though it is designed primarily to take the place of the horse-drawn wagon covering an average route of 8 miles per day. By changing from simple to compound operation and by throttle control, the multi-cylinder engine can be made to give approximately the same torque characteristics as an electric drive, he explained.

Leather Belting Now Sold by Thickness Instead of Weight

THE American Leather Belting Association has decided that for the greater protection of the consumers of leather belting, it should establish and sell this commodity by specifications of thickness instead of weight, thereby discarding the old weight terminology of "ounces per square foot" which may be varied by the mere addition of weighting materials to the leather, and does not necessarily always represent a differential in transmission values. This decision was reached after the association had canvassed all manufacturers of belting throughout the country, with the result that 81 replies were received, all voting for the change.

The thickness specifications now in effect for first quality leather belting are as follows:

Medium Single	$\frac{10}{64}$ to $\frac{12}{64}$ in.
Heavy Single	$\frac{12}{64}$ to $\frac{14}{64}$ in.
Light Double	$\frac{15}{64}$ to $\frac{17}{64}$ in.
Medium Double	$\frac{18}{64}$ to $\frac{20}{64}$ in.
Heavy Double	$\frac{21}{64}$ to $\frac{23}{64}$ in.

1. All thicknesses in this table are average thicknesses in inches, and should be determined by measuring 20 coils and dividing this value by the number of coils measured. In rolls of belting containing less than 20 coils the average thickness should be determined by measuring one-half of the total number of coils and dividing this value by the number of coils measured.

2. The classification of "Light Single" has been eliminated entirely.

3. Uniformity: No point in either single or double belting shall be more than 2/64 in. thicker or more than 2/64 in. thinner than the average thickness.

4. The second and third quality brands of each manufacturer bear the same relative thickness to the manufacturer's first quality grades as they did in the past under the old ounces per square foot specification.

These thicknesses are now in effect and should be used by all buyers of belting in wording their orders.

Personals

ARTHUR E. POPE, vice-president in charge of operation of the New England Power Association, has just been elected president of the New England Power Company, Boston. Following several years experience in hydro-electric engineering with J. G. White & Company, New York, Mr. Pope joined the New England Power Company in 1911 as assistant to the president. He held various engineering and executive positions in that company until with the organization of the New England Power Association in 1926, he was made vice-president in charge of operation of the latter organization.

SIR HENRY FOWLER, chief mechanical engineer of the London, Midland & Scottish Railway Company, was recently elected president of the British Institute of Metals. Other officers elected are: Vice-presidents—W. R. BARCLAY, A. G. C. GWYER, Professor D. HANSON, R. S. HUTTON, H. MOORE and Vice-Admiral SIR REGINALD SKELTON; honorary treasurer, JOHN FRY; and secretary, G. SHAW SCOTT.

NEIL W. MCGILL, who was appointed director of public utilities of Cleveland, Ohio, to succeed E. H. KRUEGER, resigned after a week in office and has been succeeded by A. R. BRUEGGEMAN.

EDGAR A. VAN DEUSEN has opened a consulting office in New York City, where he will specialize in a library research service for engineers, architects, inventors, trade and civic associations, public utilities and manufacturers. During the past 25 years Mr. Van Deusen has been employed in various engineering and management capacities, particularly in connection with hydro-electric developments, transmission line and substation structures.

JOHN W. BAUMGARTNER, civil engineer, has been appointed to the Los Angeles (Calif.) Water and Power Commission as a successor to O. T. JOHNSON, JR., resigned. The City Council unanimously confirmed the appointment of Mr. Baumgartner after rejecting four nominations made by Mayor John C. Porter.

J. D. PETERS, superintendent of the Light and Power Department of the City of Moose Jaw, Sask., was elected president of the Saskatchewan Branch of the Engineering Institute of Canada, at the annual meeting March 18. Other new officers include: Vice-president, P. C. PERRY, division engineer of the Canadian National Railways, Regina; and secretary-treasurer, STEWART YOUNG, director of town planning for the province, Regina.

J. F. FAIRMAN, assistant electrical engineer of the Brooklyn Edison Company since 1926, has been appointed electrical engineer of that company.

How's Business?

MOST business indicators continue to recede, aside from spurts in coal production and shipments due to weather and strike conditions. Steel activity still waits upon a spring pick-up in automobile output, and this in turn upon Ford plans. Hesitancy in the heavy industries is contributing to declining power production (1,537,747,000 kw.-hr. for the week ended March 19, according to the N.E.L.A.). March building figures show the consequences of almost complete suspension of public improvements. Prospects for improvement in the business picture in the next two months depend principally upon the outcome of the automobile sales drive under way, alteration in banking attitude toward credit expansion, and settlement of the federal tax issue. — *The Business Week*, March 30.

Business Notes

ASHTON VALVE COMPANY, Cambridge, Boston, Mass., announces the removal of its New York City offices to 21-23 Albany Street (90 West Street Building), effective on or about April 15. Larger and more commodious, the new quarters will permit increased stock and service facilities, the company states.

BONNEY FORGE & TOOL WORKS, Allentown, Pa., announces that G. Fred Sherman, formerly assistant sales manager of Tube-Turns, Inc., Louisville, Ky., was recently appointed sales manager of its Forged Fittings Division. The company also announces that Ben Bush and Howard F. Grimes have joined the sales staff of the division. Mr. Bush will have charge of selling in the New York and Pennsylvania district, while Mr. Grimes will cover the Middle Western section.

AMERICAN SMOKE & SOOT WASHER COMPANY, New York City, announces the appointment as New York district sales manager of G. O. French, who since 1927 has been in charge of sales at the New York district office of the Air Preheater Corporation of New York.

FROST RESEARCH LABORATORY, INC., Norristown, Pa., announces an expansion of its activities with the election of new officers. Robinson V. Frost, who established the laboratory in 1925, will continue as president and director, with A. S. Armagnac, vice-president, and Gustave Petersen, secretary-treasurer. Mr. Armagnac and Mr. Petersen have been associated for many years as publishers of *The Heating and Ventilating Magazine*. They will maintain headquarters at 30 Church St., New York City, where a branch office of the laboratory has been opened.

NEILAN COMPANY (Division of Mason Company), Los Angeles, Calif., and the MASON REGULATOR COMPANY, Boston, Mass., announce the establishment of a joint branch office at 409 East Archer St., Tulsa, Okla. Gordon Thomason, widely known in the oil and gas industry, will be in charge of the new office.

Trade Catalogs

STOKERS—"The One Stoker for Any Coal" is the title of a new bulletin (No. 101) released by the Whiting Corporation, Harvey, Ill., which contains an illustrated description of the principle and construction features of the Whiting stoker. In addition it presents data on operation, maintenance, costs, and other pertinent facts for the buyer.

ELECTRICAL DEVICES—Allen-Bradley Company, Milwaukee, Wis., has just published 31 new loose-leaf bulletins and price sheets, bringing its complete catalog of electrical equipment up to date. With illustrations and descriptive matter, the bulletins cover automatic d.c. motor starters, reverse switches, speed controllers and regulators, contactors, starting switches for various types of motors, photo-electric relays, safety devices and accessories.

REFRACTORIES—An illustrated folder, describing the characteristics and applications of "Wetkrome" ready-mixed chrome-ore cement, has just been issued by E. J. Lavino & Company, Bullitt Building, Philadelphia, Pa.

SCREW PUMPS—Bulletin 145, just issued by the Morris Machine Works, Baldwinsville, N. Y., describes in detail the construction and operation of screw pumps specially adapted to handle large volumes of water against low heads. Illustrations and sectional views are included, together with performance tables and curves showing operating characteristics.

BEARINGS—The construction, applications and installation of "Metaline" oilless bearings are covered in a booklet recently issued by the R. W. Rhoades Metaline Company, Long Island City, N. Y.

VARIABLE SPEED TRANSMISSION — Construction and operating features of the Lewellen variable speed transmission are described and illustrated in a folder just released by the Lewellen Manufacturing Company, Columbus, Ind. Sectional and detail drawings are shown.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Marysville—Marysville Ice & Cold Storage Co., has work under way on construction of an ice storage plant, 1,200 ton capacity, on 9th St. W. W. Williamson, 320 Market St., San Francisco, general contractor.

Colo., Brandon — Burrell Seed Co., Rocky Ford, plans irrigation development in Kiowa county near here including installation of six pumping plants at experimental farm.

Colo., Colorado Springs—City retained Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, Mo., consulting engineers, to prepare plans for addition to steam power plant, including 5,000 kw. 80 per cent power factor turbo generator set, boiler and steam generating unit with auxiliary appurtenances. Estimated cost $260,000.

Colo., Palisade—Bureau of Reclamation, Denver, will receive bids until May 24 for construction of a 3,000 kw. hydro-electric plant. $128,000. Entire project including installation of machinery. $215,000.

Colo., Vineland—G. R. Pratt Ice Co., R. R. No. 1, Pueblo, will soon start work on construction of artificial ice manufacturing plant here. Maturity early summer.

Conn., East Hartford—Albert McClellan, 790 Tolland St., completed plans for construction of a 1 story, 32 x 35 and 25 x 25 ft. ice manufacturing plant. Estimated cost $40,000. Private plans.

Conn., Mystic—Mystic Ice Co., Frank Bergman, Mgr., Noank Road, Noank, plans completed for construction of a 20 ton ice manufacturing plant. Estimated cost $40,000. Private plans.

D. C., Washington—Treasury Department, Office of Supervising Architect, received lowest bid for four boilers for central heating plant, at public buildings, from Combustion Engineering Corp., 200 Madison Ave., New York, $426,-431; fifth and sixth $106,608 each.

Kan., Wichita—City will soon award contract for water supply for sewage disposal plant to include well, pump, storage tank, etc. P. L. Brockway, City Hall, is engineer.

Md., Baltimore—Treasury Department, Office of Supervising Architect, Washington, D. C., will receive bids until April 15 for construction of main building, power house, garage and laundry building at U. S. Marine Hospital here.

Mass., Boston—Christian Science Publishing Society, 107 Falmouth St., awarded contract for electric work on sub-station for publication building at Norway, Falmouth and Clearway Sts. to Hixon Electric Co., 22 Elkins St., South Boston.

Mass., Boston—Hospital Department, will receive bids until April 6 for alterations to power house at City Hospital, Harrison Ave. Estimated cost $100,000. J. H. Ritchie & Associates, 250 Stuart St., are engineers.

Mass., Leominster—Leominster Ice Co., 229 Pleasant St., awarded contract for construction of ice manufacturing plant to J. Lagey, 416 Pleasant St. Estimated cost $40,000.

Minn., Duluth—City, c/o John Wilson, Engr., preparing plans and specifications for sewage disposal system including treatment plant, pumping stations, pumping units, chlorination plant, force mains, etc. Estimated total cost $310,000.

Neb., Kearney — Farmers National Grain Corp., 733 Omaha Grain Exchange Bldg., Omaha, acquired a site and plans construction of a grain elevator, 500,000 bu. capacity here. Architect and engineer not selected. West Central Grain Corp., lessee.

N. J., Newark—Public Service Electric & Gas Co., 80 Park Pl., awarded contract for reconstruction of 2 story electric sub-station at 1227 Broad St. destroyed by fire to United Engineers & Constructors Inc., 80 Park Pl. Estimated cost $40,000.

N. Y., Wingdale — Department of Mental Hygiene, State Office Bldg., Albany, will receive bids until March 30 for refrigeration work, kitchen and dining room building No. 24, cold storage plant, storehouse and bakery at Harlem State Hospital here.

O., Oberlin — Oberlin College, c/o F. M. Cruitsinger, Supt. of Const., will soon receive bids for construction of central heating plant. Estimated cost $325,000. John P. Jones, Cary & Muller Inc., Terminal Tower, Cleveland, are architects and engineers.

O., Piqua—City will soon receive new bids for construction of municipal power plant including turbine generator, surface condenser, steam generating unit, boilers, exhaust fans, motors, Diesel engine, etc. Estimated cost $810,000. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., are engineers. Injunction suit settled.

Ore., Roseburg — U. S. Veterans' Bureau, Washington, D. C., will receive bids until April 1 (extended date), for construction and finishing complete buildings and utilities including refrigeration and ice-making plant, boiler plant equipment, heating and ventilating systems, etc., at Veterans' Administration Home here.

Pa., South Donora—U. S. Engineer, W. D. Styer, Dist. Engr., Keenan Bldg., Pittsburgh, awarded contract for construction of two power houses and administration building at Lock and Dam No. 4 to H. Miller & Sons, 2565 5th Ave., Pittsburgh, $17,900.

Tex., Marlin—Marlin Ice & Cold Storage Co., awarded contract for construction of a 1 story, 47 x 70 ft. ice plant to Frank Petzold, Marlin.

Va., Roanoke — Roanoke Waterworks Co., C. E. Moore, V. Pres., plans waterworks expansion program to cost $1,500,000 over 20 year period. Surveys conducted by E. B. Whitman of Whitman, Requardt & Smith, Baltimore Trust Bldg., Baltimore, Md. Work includes additions to fire and service mains, storage facilities for territories supplied by booster pumps and new sources of water supply; continued development of present Carvin's Cove storage reservoir with filter and treatment plant and 50 in. pressure main, six mi. into Roanoke, ultimate capacity 25 m.g.p.d.

Wash., Malaga—Lockwood & Canady Irrigation Co., will soon award contract for construction of a pumping plant including 1,100 and 2,500 g.p.m. motor driven centrifugal pumps. Estimated cost $25,000. J. R. Bannon is engineer.

Wash., Pullman—Associated Students, plans construction of a 1 story, 100 x 100 ft. ice arena, including equipment. Estimated cost $100,000. Stanley Smith, Washington State College, is architect.

Wash., Puyallup—Puyallup & Sumner Fruit Growers Association, L. M. Hatch, Pres., awarded contract for construction of a 1 story, 77 x 167 ft. addition to cold storage plant to S. R. Gray, Puyallup. Estimated cost $40,000.

Wash., Stevenson—City plans an election to vote $100,000 bonds for construction of municipal hydro-electric plant. Engineer not selected.

Wis., Marshfield—Steven J. Miller, 101 North Vine St., having plans prepared for construction of a cold storage warehouse including equipment. Estimated cost $40,000. Private plans.

Ont., London—London Memorial Park Co., Charles G. Secord, Mgr., 291 Dundas St., plans to expend $100,000 for construction of administration building, including power plant, water and steam heating system, etc. Watt & Blackwell, Victor Bldg., Dundas St., London, are architects.

Equipment Wanted

Boiler—Memphis, Tenn.—District Engineer, U. S. Engineer Office, McCall Bldg., will receive bids until April 5 for locomotive type boiler, 100 hp. capacity complete with necessary fittings, grates and stack.

Engine, Generator, Exciter, Switchboard, etc. —Whitehall, Ill.—City will receive bids about April 22 for Diesel engine, generator, exciter, switchboard, transformers, etc., in connection with proposed municipal light and power plant and distribution system.

Power Equipment — New York — Board of Transportation, J. H. Delaney, Chn., 250 Hudson St., New York, will receive bids until April 8 for furnishing and installing auxiliary power equipment for Queens Line of Independent system of City-owned Rapid Transit Railroads, borough of Queens.

Power Plant Equipment—Brooklyn, N. Y.—Department of Mental Hygiene, State Office Bldg., Albany, will receive bids until April 13 for power plant equipment, etc., for Brooklyn State Hospital here.

Pump—Chaska, Minn.—City will receive bids until March 31 for furnishing and installing one deep well turbine pump complete with motor, starter, etc., for proposed waterworks improvements.

Pump—Sioux Falls, S. D.—Board of Commissioners, W. C. Leyse, Auditor, will receive bids until April 7 for furnishing and installing new pump and other additions in iron removal plant of city waterworks.

Pump, etc.—Huntington, W. Va.—U. S. Engineer Office, War Dept., will receive bids until April 5 for two 200 g.p.m. vertical triplex plunger pumps against a pressure of 430 lb. each driven through silent chain by two 60 hp., 900 r.p.m. normal torque low starting current motors for operation on 440 v., 3 ph., 60 cycle alternating current, one motor only complete with electrical control for temporary operation; also hydro-pneumatic two-compartment accumulator 24 in. diameter and steel pump priming tank, 700 gal. capacity.

Pumping Equipment—Auburn, Ind.—City will receive bids until April 4 for furnishing and installing pumping equipment, etc., in connection with municipal waterworks. $15,000.

Pumps—Moline, Ill.—City will receive bids until April 8 for two low lift pumps in connection with waterworks filtration plant. $350,000.

Pumps—Jamestown, N. D.—City will soon receive bids for furnishing and installing two motor driven pumps for water department.

Pumps — Green Bay, Wis. — City, M. P. Doherty, Clk., plans installation of two 1,500 g.p.m. and one 1,000 g.p.m. pumps in connection with electrification of pumping station.

Industrial Projects

Ind., Hammond—Stone & Webster Engineering Co., 49 Federal St., Boston, Mass., receiving bids on all contracts for a 4 story soap factory here for Lever Bros., Hammond. Estimated cost $500,000.

Okla., Picher—Eagle-Picher Lead Co., c/o Temple Bank Bldg., Main and Commercial Sts., Cincinnati, O., awarded contracts for excavation and structural steel for lead and zinc concentration plant, including 68 x 68 x 71 ft. 1,200 ton and 50 x 112 x 26, 5,000 ton hoppers. Estimated cost $400,000.

Tex., Corpus Christi—John Remonte, plans construction of a refrigertor manufacturing plant.

Tex., Houston—Continental Can Co., Pershing Sq., New York, N. Y., plans construction of a can manufacturing plant here. Estimated cost $40,000. Favrot & Livaudais, Hibernia Bldg., New Orleans, La., are architects.

Tex., Jacksboro — Jacksboro Gin, c/o A. Brown, Mgr., plans construction of a cotton gin plant. Private plans. Interested on quotations on gas or gasoline engine, gin stands, feeder and huller.

Tex., McAllen—Walter K. Campbell, Wichita Falls, plans construction of a refinery plant to handle 400 bbl. of crude oil daily. Will install lubricating unit now and later a cracking unit, also building pipe line for transporting oil to Missouri Pacific R.R. right-of-way. Private plans.

Tex., Orange—Commercial Pulp & Paper Co., headed by S. M. Bump, Orange, purchased properties of Yellow Pine Paper Mill and plans renovating and repairing paper mill, including new equipment. Estimated cost $75,000. Work will be done by owner's forces. C. A. Kieren, superintendent.

Utah, Salt Lake City—Utah Oil Refining Co., having preliminary plans prepared for additions and alterations to refinery including installation of new type gasoline absorption plant and revision of refining equipment. Estimated cost $400,000. E. S. Holt, Salt Lake City, is engineer.

B. C., Prince Rupert—F. L. Buckley, Vancouver, plans establishment of a bleached Swedish sulphite pulp mill here, 200 ton capacity using approximately 700,000 ft. of logs daily.

Ont., York — McQuay-Norris Manufacturing Co., 37 Pearl St., Toronto, awarded contract for construction of a 1 story factory for the manufacture of piston rings at Ray and Goddard Aves. to Austin Co. Ltd., 320 Bay St., Toronto. Estimated cost $50,000 to $60,000.

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